# CIVIL ENGINEERING

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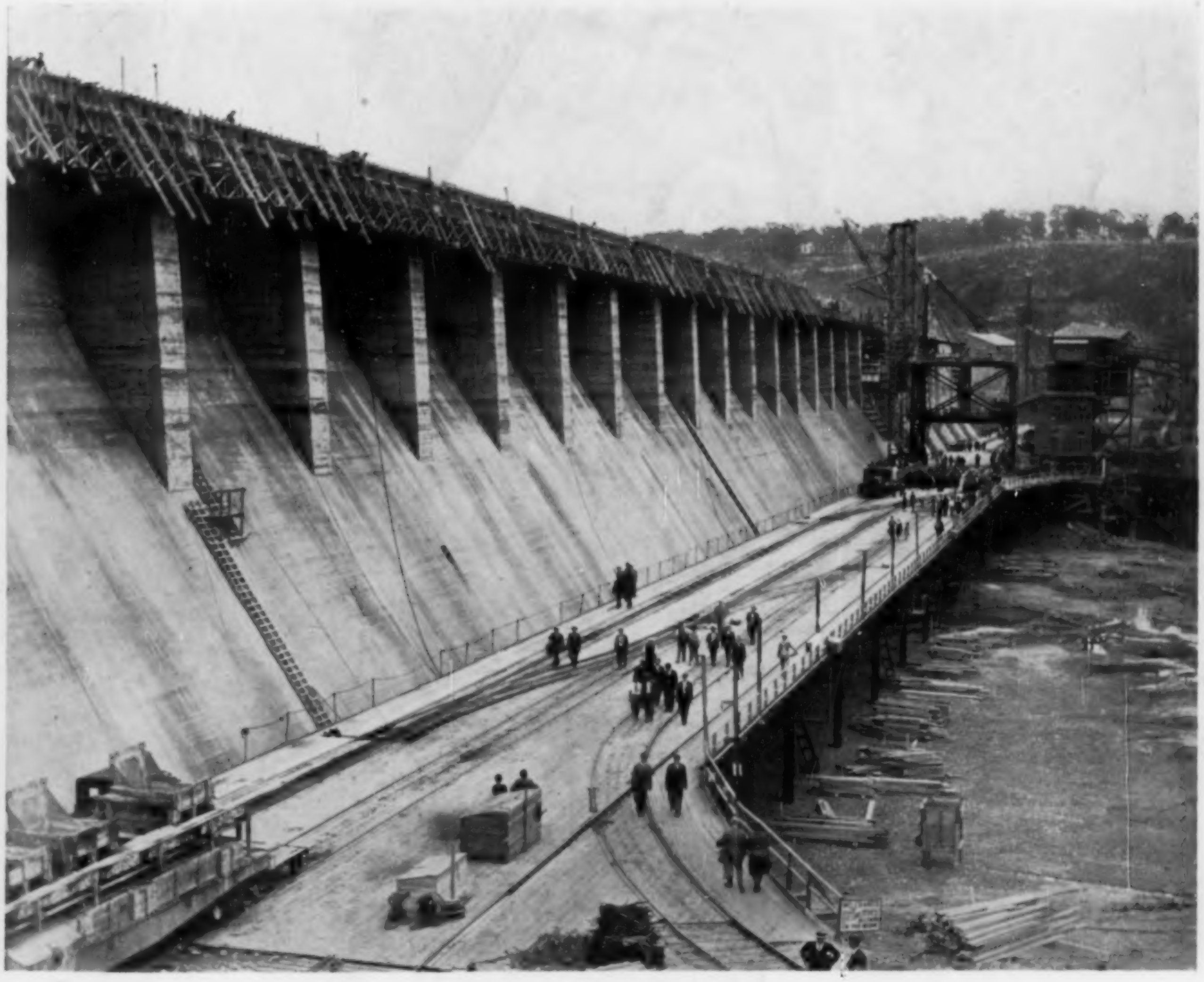
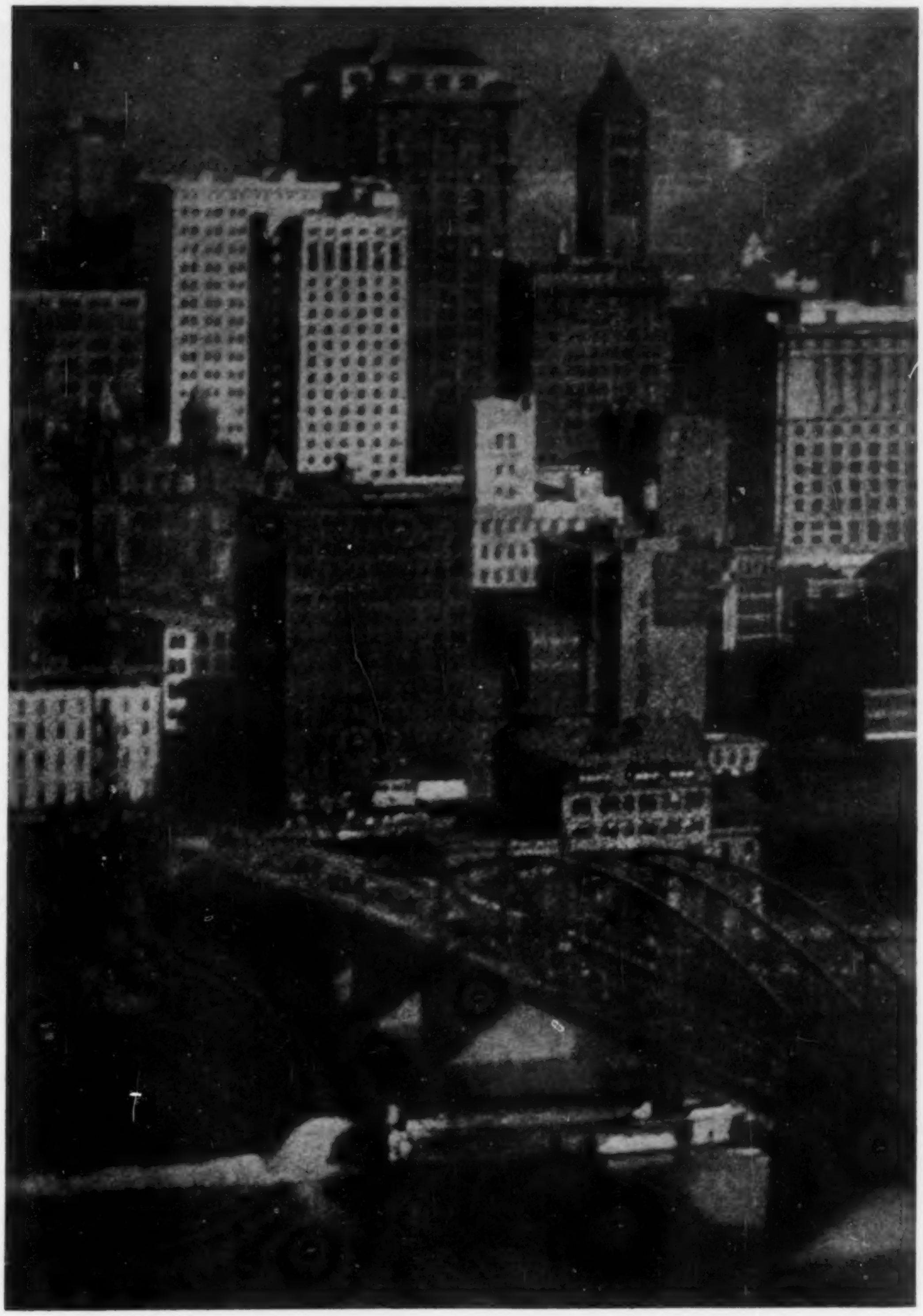


BAGNELL DAM INSPECTED BY AMERICAN SOCIETY OF CIVIL ENGINEERS

*Volume 1* AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 4*

JANUARY 1931



THE MIGHTY CITY
*George H. Morse*

*A REPRODUCTION of an interesting bromoil from the exhibition of Art by Engineers in connection with the Fifty-First Annual Meeting of The American Society of Mechanical Engineers, December, 1930, New York.*

# Among Our Writers

GEORGE R. STRANDBERG has, for 15 years, been with Stone and Webster Engineering Corporation, on various important works, notably the Conowingo Power Project.

F. G. DANA has become an aviation enthusiast as a result of his experience with transmission line surveys.

WALTER F. SCHULZ, a native of Berlin, was Construction Engineer on the Memphis Union Station.

MAJ. L. D. WORSHAM finished his military education at West Point in 1916 and did graduate work at Massachusetts Institute of Technology.

GEORGE R. CLEMENS has had five years intimate contact with Government study and investigation of inland waterways.

WILLIAM F. GEPHART, who has the Doctor of Philosophy degree from Columbia, is an authority on economics and banking.

EDMUND R. KINSEY'S 20 years of private engineering practice in St. Louis have been followed by a career of public service.

ALBERT P. GREENSFELDER, after six years of varied terminal and railroad construction work, became associated with the firm of which he is now president.

EDWARD E. WALL has, since 1890, been identified with the engineering features of the development of St. Louis.

WESLEY W. HORNER has, for many years, specialized in the study of rainfall in sewers, sewer design, and pavement construction.

FRANK G. JONAH began his railroad career nearly 30 years ago. During the war, Col. Jonah was Chief Engineer of Light Railways.

RICHARD J. LOCKWOOD has been Vice-President and General Manager of the Apalachicola Northern Railroad and of the Port St. Joe Dock and Terminal Company.

MAJ. MILO P. FOX has been intimately connected with the Brazos River and Freeport Harbor problems for a number of years.

ROBERT B. BROOKS has a background of many years of municipal construction experience as a contractor.

ALAN J. PARRISH is Vice-President of the Illinois Association of Highway and Municipal Contractors.

WARD P. CHRISTIE for a number of years was Research Engineer of the Associated General Contractors of America.

W. W. ZASS has been with the Arkansas State Highway Department since 1924.

W. J. NEWMAN has perhaps put in more open-well foundations in Chicago than has any other one man.

L. R. VITERBO, a native of Constantinople, gained his early engineering experience in Paris.

ARTHUR C. EVERHAM brought to the Raymond Concrete Pile Company with which he has been associated since 1919, a long experience on heavy construction work.

S. W. BOWEN has specialized in the erection of steel work for bridges and buildings and the construction of concrete, timber, and steel structures.

O. E. MOGENSEN, a native of Denmark, received his engineering degree from the Polytechnic School at Copenhagen.

THOMAS H. CUTLER brought to the Missouri State Highway Department many years of contracting experience on drainage, highway and heavy foundations construction.

R. W. JABLONSKY has devoted 20 years to the problems of highway design and construction.

JAMES S. TAYLOR began in 1921 with the Division of Building and Housing of which he is now Chief.

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# The Osage Hydro-Electric Project

*Bagnell Dam Creates Missouri's Only Large Lake*

*By* G. R. Strandberg

Member American Society of Civil Engineers
Project Engineer, Stone and Webster Engineering Corporation, Boston

*When the Osage hydro-electric project is completed this year for the Union Electric Light and Power Company of St. Louis, there will be created the only large lake in the State of Missouri, and the fourth largest artificial lake in the United States. This lake, which is appropriately to be known as the Lake of the Ozarks, will wind among the foothills at the northern edge of the Ozark plateau for a distance of 130 miles. One of the successful trips in connection with the Fall Meeting of the Society at St. Louis was an all-day, special-train excursion to the Bagnell Dam. Nearly 600 members and guests accepted the hospitality of the Missouri-Pacific Railroad Company, the Union Electric Light and Power Company, and the Stone and Webster Engineering Corporation on October 4, 1930.*

Among the picturesque secondary streams of the State of Missouri is the Osage River. With headwaters in the eastern part of Kansas it winds through the central western part of Missouri and flows into the Missouri River about eight miles below Jefferson City. The lower end of the lake, created by the dam, will be about four miles upstream from the town of Bagnell or about halfway between St. Louis and Kansas City, and about 75 miles above the confluence of the Osage and Missouri Rivers. Above the dam site, near Bagnell, it drains an area of 14,000 sq. miles and the average fall through the 130-mile stretch of the reservoir is less than 0.8 ft. per mile. The river flow is subject to extreme variation, the maximum and minimum recorded flows being 110,000 sec-ft. and 324 sec-ft., respectively, with an average flow of 10,500 sec-ft. for the 13-year period of record.

### Geology of Project Site

In addition to a very complete core-boring examination of the dam site, the reservoir area and dam site were carefully explored by geologists, before other than preliminary plans were made for the development, to determine with reasonable assurance that the foundation for the dam was satisfactory and that the reservoir would be tight.

The foundation at the dam site consists of Gasconade dolomite overlying a comparatively shallow layer of Gunter sandstone, having an average thickness of about 8 ft., under which there is a deep formation of Proctor dolomite. Across the central part of the river bed, for a width of about 1,000 ft., the Gasconade dolomite has been eroded to the Gunter sandstone. Over the rock bed of the valley, which is remarkably level along the dam site for about 1,700 ft., is a bed of gravel about 25 ft. in depth which, in turn, is covered by about 25 ft. of silt.

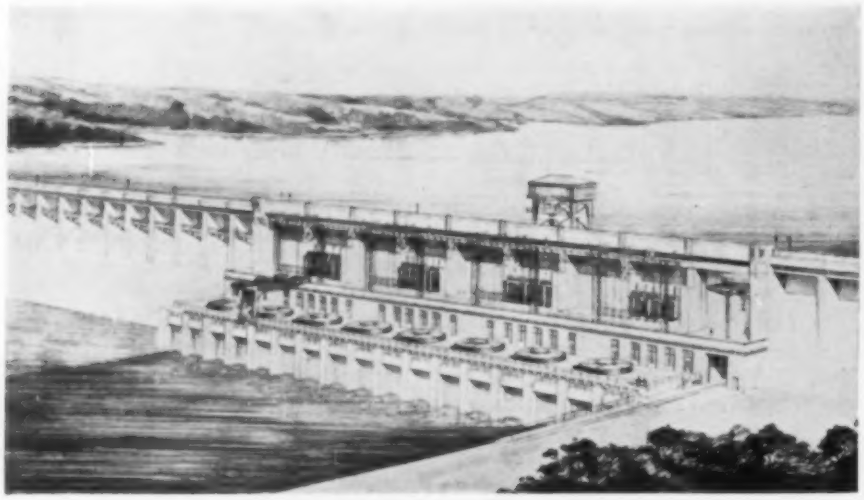
The normal river channel is approximately 400 ft. wide with its bottom in the gravel strata about 15 ft. above the rock, and at the dam site the channel is near the eastern side of the valley. During floods, which occur almost every year, the river overflows the

Osage Project—Union Electric Light and Power Company

silt banks, sometimes to a depth as great as 10 to 15 ft.

### AVAILABLE POWER

Due to the rather protracted low-flow periods to which the Osage River is subject, any development of a large block of power would be dependent, at times,



BAGNELL DAM AND HYDRO-ELECTRIC STATION

mainly on water stored in the reservoir. A new concrete arch bridge to carry the main highway over the Osage River just below Warsaw, and the excessive land and property damage that would result from a higher dam, fixed the most economical limit for the development at a normal and maximum reservoir elevation 660 ft. above mean sea level. At this level the reservoir area is estimated at approximately 95 sq. miles, or 61,000 acres and, with a 30-ft. draw-down, over 1,200,000 acre-ft. of storage will be available, or more than sufficient storage to equalize completely the flow throughout a record dry year.

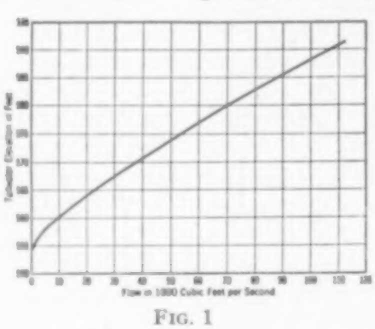


FIG. 1

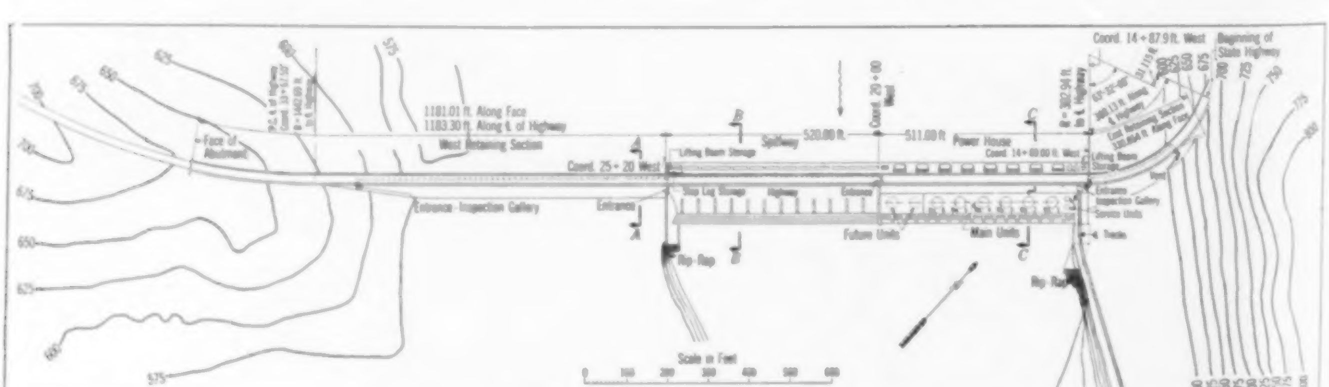
Tailwater level at the site varies with the flow from a minimum elevation at about 554 ft. to a maximum elevation at 592 ft. above mean sea level, as shown at right, which, with a reservoir at elevation 660 ft., gives a head varying between 106 ft. and 68 ft. The possible energy at the site is estimated to vary between about 150,000,000 kw-hr. in a dry year, and over 800,000,000 kw-hr. in a wet year. The estimated average for the period of years for which records are available is about 425,000,000 kw-hr. per year.

This Osage development will form the third of a group of widely separated, dependable power sources for the Union Electric Light and Power Company, the two existing sources being the steam stations at St. Louis (Cahokia at East St. Louis and Ashley Street in St. Louis) and the Keokuk hydro-electric station at Keokuk, Iowa. With its large storage capacity, the Osage plant becomes naturally a peak-load plant and its ultimate economical capacity is not entirely dependent on the available river flow, since the peak-load energy requirements for a given capacity on the St. Louis system load become less each year as the peaks grow sharper.

### ULTIMATE STATION CAPACITY

Comparative analyses of different transmission voltages showed that 132,000 volts would be the cheapest when the existing substations and transmission lines of the company were taken into consideration. It also developed that the Osage station should be connected to the St. Louis system at two points, one being a connection to the Page Avenue substation in the northwest part of the city, where the Keokuk station ties into the system, and the other a connection at Crystal City, south of St. Louis, at the end of an existing transmission line connection to Cahokia station.

Although the Osage station is located about 140 miles from the load at St. Louis, the station with its modern water wheels, generators, and transformers operating mainly for peak loads was considered, with the installation of a spare transmission circuit, to be the equivalent of prime capacity for the system. While the major portion of the possible energy output from the Osage site could be made available at St. Louis by an installa-




PLAN OF BAGNELL DAM

tion of about 120,000-kw. generating capacity at the site, this output required four 132,000-volt circuits including the spare circuit, and with this transmission capacity installed, stability studies of the system indicated that about 170,000 kw. could be transmitted safely.

Any installation smaller than this amount would not utilize the transmission system to its capacity and the marginal cost of capacity up to this limit would be less than for equivalent capacity installed in steam at St. Louis. Capacity beyond this limit would require the addition of transmission capacity as well as terminal facilities at St. Louis, and the total additional cost for such capacity could not be justified. The station was, therefore, designed on the basis of approximately this ultimate capacity of 170,000 kw.

In order to economically use all of the power from the initial development of the project, it was necessary to find a new market for a portion of the power, and this market was obtained through a contract with the St. Joseph Lead Company, located about 60 miles south of St. Louis near Bonne Terre and Rivermines. The 132,000-volt lines of the Union Electric Light and Power Company already extended about half the distance to Rivermines from St. Louis so that after a contract was made with the St. Joseph Lead Company (which is for one of the largest single blocks of power ever sold to a private enterprise, approximately 150,000,000 kw-hr. per year) it was simply necessary to extend these lines south and then directly west to the project. Thus a portion of the power will be sold on the way in to St. Louis.

### General Description of Plant

The development consists of a concrete dam of gravity section and a power station built integral with the dam. The dam is 2,543 ft. long and has a maximum height of 148 ft. from bedrock to the floor of the bridge over the top of the dam. The power-station section, which is located in the river channel, is 511 ft. long. East of the power station is a short retaining section, and west of the station is the spillway which is 520 ft. long. From the spillway to the west bank is the main retaining section. The dam is surmounted by a roadway 20 ft. wide, which will serve as the river crossing of U.S. Highway No. 54. A 3-ft. sidewalk extends along the highway on the downstream side. An inspection tunnel is built into the dam above ordinary tailwater level for most of the length of the dam.

Aerial View of the Working Area

### Dam Foundation Prepared

Under the spillway section, the exposed sandstone was all removed and the dam built on the Proctor dolomite with a key trench 20 ft. wide cut into it at the heel. The retaining sections and the power-station section were built on the Gasconade dolomite, which overlies the sandstone, for the greater part of their length with a similar key trench at the heel except at the abutments where the rock was removed to permit keying the entire section into the hillsides.

A longitudinal drain was installed just downstream from the key trench along the entire length of the dam and this drain was connected to the downstream face by lateral drains approximately 40 ft. on centers. Two rows of grout holes 5 ft. on centers, and staggered, were drilled about 30 ft. into the rock under the key trench

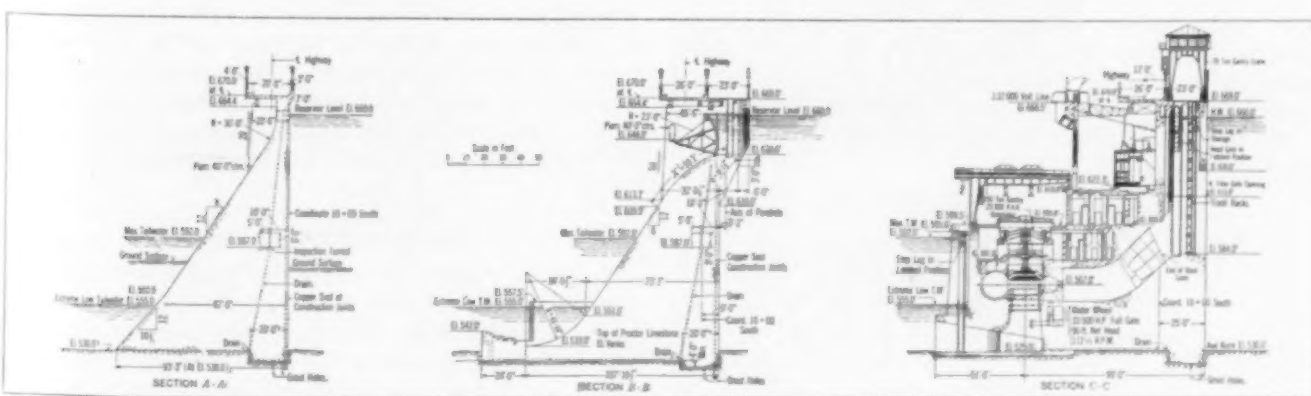


Fig. 2. Section of Bagnell Dam

and about $2^1/_2$ ft. from the upstream face to the first row for the full length of the dam, to form a grout curtain at the upstream side and reduce seepage to a minimum.

DESIGNING THE SPILLWAY SECTION

The spillway is designed to have a capacity of 162,000 sec-ft. without exceeding the normal pond elevation and not including any flow through the power station. In the spillway section are located 12 Tainter gates each 34 ft. long and 23 ft. high with 6-ft. piers intervening, which support the gate trunnions, the highway, and operating deck above. The operating deck is upstream from the highway and provides working space for two 70-ton gantry cranes which will be used to operate the Tainter gates as well as the head gates for the power station, and to place or remove the trash-rack sections and stop logs in front of either the Tainter gates or the head gates. A compressed-air system is installed along the spillway to be used to prevent the building up of ice pressure against the Tainter gates.

GENERAL VIEW OF THE PROJECT
Equipment in Use and Methods of Construction, November 1930

The spillway, which has an ogee section, is provided with a stepped apron 24 ft. wide, made up of four ascending steps each 6 ft. wide starting at the horizontal tangent of the bucket and rising 36 in., 15 in., 15 in., and 24 in., respectively. The last step has an upward slope of one vertical to four horizontal. This apron design was the result of an exhaustive series of tests made with various kinds of spillway aprons using models of 1 to 40 scale at the hydraulic laboratory of the Worcester Polytechnic Institute. The apron is designed to dissipate to a large degree the energy in the lower portion of the overflowing jet within the limits of the apron and deflect the turbulent water to the surface of the tailwater, which will have a minimum depth of about 25 ft. over the top of the apron toe. Model tests of this apron indicated that the jet action on the river bed would be eliminated and that scour due to turbulence and eddies would be reduced to a negligible amount.

SLOPE OF RETAINING SECTIONS

The retaining sections of the dam have a vertical upstream face and a slope of 8 horizontal to 12 vertical on the downstream face except for the lower 30 ft. of the maximum section where the slope is changed to $10^1/_2$ horizontal to 12 vertical. While the section is backfilled along the downstream side for a depth of about 40 ft. to elevation 570 at the west abutment and 65 ft. to elevation 595 at the east abutment, this backfill was not considered in the stability analysis of the section.

With its cover of about 50 ft. of gravel and silt over the major portion of the valley, the dam site would suggest the use of an earth dam for the retaining section and comparisons were made between earth and concrete sections. While the earth section showed a material saving in construction cost alone, it did not lend itself to rapid construction and, in fact, would have required at least one year longer to build. A concrete section was finally decided upon because of the shorter length of time to build it and because it appeared to have other advantages which, combined, more than outweighed the apparent saving in construction cost.

POWER STATION SECTION

The power station section is designed for the installation of eight main units and two station service units. The headworks section acts essentially as a gravity dam although the upper portion, containing the intakes, racks, and gates, is of reinforced concrete. Leading through the headworks to the scroll cases of the main units are the plate-steel-lined penstocks. The intakes are equipped with fixed roller type head gates and vertical type trash racks. The trash racks are in sections which can be easily removed and a trash rake is being provided. At the upstream face of the headworks is a skimmer wall which extends down into the water 30 ft. below the normal reservoir level.

Immediately downstream from the headworks is the power station with the electrical bay built over the penstocks, between the generators and the headworks wall. The step-up transformers and getaway structure for the transmission lines are located over the electrical bay with the transformers under the highway bridge and a transformer transfer track between the getaway structure columns and the transformers. On the getaway structure are mounted the line disconnecting switches, carrier-current coupling condensers, and lightning-arrester equipment.

POWER STATION EQUIPMENT

Initial equipment for the power station will consist of six main hydro-electric units and two-station service units of the same type, with provision in the substructure for two additional main units. The main water-wheel units, which are being furnished by the Allis-Chalmers Manufacturing Company, are of the vertical-shaft

Francis type of 33,500 hp. full gate capacity under a 90-ft. net head, operating at 112.5 revolutions per minute and designed to give 30,000 hp. at best gate. Each water wheel is direct connected to an umbrella-type, 13,800-volt, 3-phase, 60-cycle generator having a continuous capacity of 23,888 kva., at 0.9 power-factor and 60 deg. cent. rise or 27,500 kw. at 1.00 power-factor and 80 deg. cent. rise. The generators are being furnished by Westinghouse Electric and Manufacturing Company.

The water wheels have plate-steel scroll cases incased in concrete, and reinforced-concrete draft tubes with short plate-steel liners directly below the runners. An inspection and drainage tunnel is located upstream from the draft tubes and directly below the scroll cases. Stop-log slots are provided at the draft-tube outlets with sufficient stop logs for one main and one-station service unit, and the draft tubes and scroll cases are all connected to a 24-in. unwatering header, to which two unwatering pumps are connected at the east end.

The Dam Nearing Completion
Photograph Taken October 4, 1930, During the Visit of the American Society of Civil Engineers

Each main generator has a closed water-cooled air circulating system. The air discharging out through the windings is carried through metal housings around the generators and passed through air coolers located at each side of the generator along the longitudinal center line of the generator room thence up to the closed chamber over the top of the generator and back down and out through the windings. The closed system of generator air cooling reduces the amount of dirt deposited on the windings. At certain times of the year the Osage Valley is infested with large numbers of bugs which would have necessitated the screening of all the air intakes of an open system.

At a material saving, the superstructure over the generator room was omitted, the power station crane being made of the outdoor type with one gantry leg, the other crane rail being located on the top of the wall of the electrical bay. With umbrella-type generators and a closed air circulating system, all normal operating access to the generators will be from the wheel pit below the generator. With the installation of motor-generator exciter sets located on the main water-wheel floor, all auxiliary equipment will be located on one floor. By raising the next floor but a few feet higher than required to protect the station from floods, it was possible, as shown on the cross section of the station, Fig. 2, to locate the generators below this latter floor with only a metal housing projecting above the floor.

Metal covers over the generators are located high enough so that by the use of the jacks and the power-station crane, operating through a smaller cover in the center of the main cover, the rotor can be lifted clear of the stator and supported on a shaft extension under the main cover. All repairs to the rotors or stators that would normally be made in the power station can therefore be made under the covers.

### Transformers

For the initial installation, there will be three 60,000-kva. main-power transformer banks, manufactured by the General Electric Company, each bank consisting of three single transformers rated at 13,333–20,000 kva. and 13,800–132,000 volts. The 20,000-kva. rating will be obtained by means of air-blast equipment. Ultimately there will be four 60,000-kva. transformer banks.

### Electrical Connections to be Made

Initially, a pair of generator units will be connected through oil circuit breakers to each 60,000-kva. transformer bank. Each transformer is connected directly to a transmission line without high-tension oil circuit breakers.

Provision is made for installation in the future of a sectionalized 13,800-volt station bus, to which four of the eight generating units will be connected through their respective generator oil circuit breakers. The connections for each of the four remaining generator units will be arranged to form a generator-transformer-line unit, with an oil circuit breaker connection to the 13,800-volt station bus, interposed between the generator and transformer oil circuit breakers.

### Station Service Supply

The essential station service auxiliaries will receive power through a 2,400-volt sectionalized single bus from two 3,000-kva., water-wheel-driven generators. Provision is made for installation in the future of a 3,000-kva., 13,800 to 2,400-volt, 3-phase transformer supplied from the 13,800-volt station bus and connected to the center of the 2,400-volt bus.

### Transmission Lines

Initially, but three 132,000-volt transmission circuits will connect the Osage plant to St. Louis. A single-circuit, wood-pole, H-frame line will connect to the Page Avenue substation, the right-of-way being wide enough for the addition of another circuit later. Two circuits on double-circuit steel towers with wooden cross arms will connect through Rivermines.

In accordance with the requirements of the Federal license for the project, the reservoir within the area exposed by a 30-ft. drawdown is being cleared of all trees, brush, and material that would float. In addition, all trees that would have their tops exposed by such a drawdown are being cut off or cut down. All material is being disposed of in such a manner that it will not float. In all, 26,000 acres of land required clearing.

SPILLWAY UNDER CONSTRUCTION IN THE COFFERDAM

LOOKING UPSTREAM THROUGH THE SPILLWAY

In addition to removal of a large number of farm houses in the reservoir area, the town of Linn Creek, county seat of Camden County, had to be removed. A new highway bridge about 1,630 ft. long had to be constructed over Grand Glaize Creek and relocation or reconstruction of a great many miles of road had to be taken care of.

CONSTRUCTION FEATURES

A construction railroad four miles long was built to the dam site from the end of the Missouri Pacific line at Bagnell, with connections to both sides of the river. A narrow gravel road connection was available from Bagnell to the site, and this road was improved for construction use. For power at the site during the construction period, a temporary steam station equipped with two 3,000-kva., steam-turbine-driven generators was constructed adjacent to the dam site.

The first section of dam constructed was the spillway and portion of abutment west of the river channel. As the gravel bed directly over the rock was water bearing, two lines of steel sheet piling were driven from the river to the west hillside, one upstream and one downstream from the dam, with a cellular-steel, sheet-piling cofferdam at the river end. The excavation was done mainly by draglines working inside this cofferdam, approximately 875,000 cu. yd. of earth and gravel being excavated.

A construction bridge, with steel columns and girders, located on the downstream side and built to an elevation that would make the operating deck safe from all possible floods, was used for the dam and power-station construction. This bridge accommodated three standard-gage railroad tracks in addition to the tracks for the three gantries which straddled the bridge and which were used to place most of the concrete not reached directly by chuting from the bridge.

The concrete plant, in which all the 550,000 cu. yd. of concrete for the dam and power station will have been mixed and in which were installed four 2-cu. yd. mixers, was located on the west side of the river just downstream from the construction bridge, with cement, sand, and gravel storage downstream and connected to the mixer plant by belt conveyors.

The method of diverting the river was to leave in the spillway section, which was constructed first, five notches, each 34 ft. wide with their sills at elevation 555, and five sluiceways. A diversion channel was dredged on both the upstream and downstream sides of the spillway section connecting the river channel to these notches and sluices. The main river channel was then closed by cellular-steel sheet piling and the power-station and east-abutment sections unwatered.

With the power-station headworks completed, the notches in the spillway will be concreted and finally reinforced concrete gates, each weighing about 80 tons, will be lowered into place to shut off the flow through each of the five sluiceways and permit filling the latter with concrete

Sand and gravel for concrete material are dredged from the river bed, $3^1/_2$ miles downstream from the dam, where they are screened and shipped to the job.

Construction work was started on August 6, 1929; the first concrete was poured $8^1/_2$ months later; and the schedule now contemplates the completion of the initial installation, ready for operation, by October 1, 1931.

In executive charge for the Union Electric Light and Power Company, are Louis H. Egan, President, and A. L. Snyder, General Manager of the Osage Project. Stone and Webster Engineering Corporation have the contract for the design and construction of the dam and power station and the transmission lines. All construction has been under the general direction of A. W. Clark, as Works Manager with H. F. Anthony, M. Am. Soc. C.E. as General Superintendent for the dam and reservoir work, and F. G. Dana as Superintendent of Transmission Lines Construction.

# Aerial Survey for Transmission-Line Location

*Stereoscopic Study of Aeroplane Photographs Successfully Locates St. Louis-Osage Transmission Lines*

*By* F. G. Dana

Superintendent of Construction, Stone and Webster Engineering Corporation

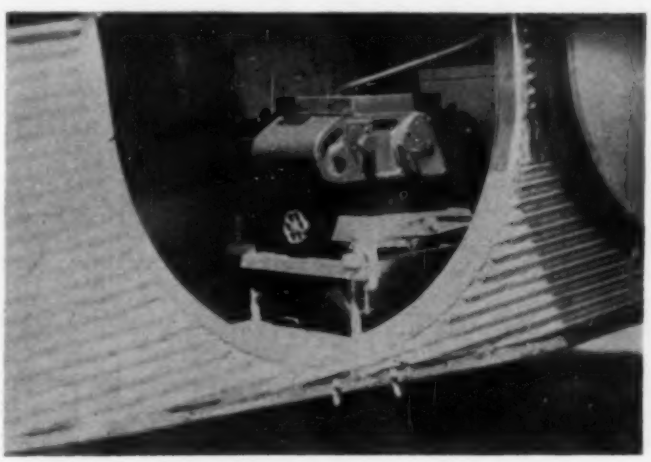
*Aerial methods were adopted on the Bagnell transmission-line locations with some misgivings, but Mr. Dana convinces the reader that the method was without a peer for this work, not only because of lower cost but also because property owners were not excited to price boosting by surveyors punching stakes across their land. The use of the stereoscope for a binocular study of overlapping photographs is emphasized. This paper was read before the Surveying and Mapping Division of the Society at its St. Louis Meeting, October 3, 1930.*

Many difficulties faced the engineers charged with locating two diverging transmission lines for the Union Electric Light and Power Company, to connect their new hydro-electric development at Bagnell, Mo., with substations at St. Louis, 138 miles distant, and at Rivermines, 122 miles from the dam, a total of 260 miles of transmission lines across difficult country in the State of Missouri.

The engineers arrived on the job in the middle of winter and found many of the roads in the territory almost impassable. In fact, a brief survey of the country indicated that there were practically no roads at all in certain sparsely settled sections where the topography was very rough, and other roads were almost impassable during the winter and early spring. Good maps were available for only a small portion of the area. In addition, it was desired to locate the lines as quickly as possible in order that right-of-way might be obtained and construction started. For these reasons, and because they had used aerial maps in a limited way on previous jobs with satisfactory results, the engineers decided to adopt aerial survey methods.

Two methods of aerial mapping were studied and it was decided to use the contact print method from photographs all taken at a constant height above the ground, which would make a photographic map of 400 ft. to the inch. A scale of 1 in. = 400 ft. was adopted, as previous experience had shown that it was the smallest that would give the desired detail. It was also the scale selected for the final right-of-way maps, of which copies would be made into prints of convenient size for the use of the right-of-way agents.

Reconnaissance work, both from the air and from the ground, was done with the aid of some topographic sheets and postal or highway maps, which were available for most of the counties. These were all reduced to the same scale and a preliminary location was laid out on each. In this way it was possible to check roads, railroads, and other controlling features which would be used as identifying points while the plane is in the air.



Camera and Mount

For use in flying, a strip map with a scale of 1 in. = 1 mile was made for each line, showing, in addition to the usual features, a rough profile of the country crossed and the elevation at which the plane should fly to produce pictures of the correct scale. The maps were mounted on sketching boards, with rolls at each end for convenience in handling them in the pilot's cockpit.

## Standard Flying Equipment Used

A Ford tri-motored plane, which had just been purchased by the Union Electric Light and Power Company, was placed at our disposal. Only slight alterations were necessary to make it suitable for the work. A camera mount, the attachment of a venturi tube, and the addition of a speed and drift indicator transformed it from a pleasure craft to a hard-working aerial transit plane. A sensitive barometer was used on the first few flights to control the altitude, but it checked so closely with the two altimeters which were a part of the plane's regular equipment that the latter were used through the survey. The locating engineer, who rode in the cockpit with the pilot, was able to give the necessary directions by means of communicating helmets.

The camera used was a standard K 5 aerial camera with a 30 cm., F 4.5 lens. It was equipped with a focal plane shutter and a timing speed ranging up to $^1/_{280}$ sec. The panchromatic film used was in 75-ft. rolls and contained one hundred 7 by 9-in. exposures. To overcome the effect of the haze, an Aero No. 1 filter was used. The camera was supported on a universal mount set over an opening in the floor of the fuselage at the rear of the passenger cabin. A photographic timer was used to time the intervals between exposures, which were usually from 6 to 10 sec. In order that the camera man might make corrections for the drift of the plane, a small cardboard protractor was placed on a bench in front of the camera, so that it could be turned to the correct angle as shown by the drift indicator.

The base for the aerial operations was the home field at St. Louis, but as

the plane had to be refueled every four hours, two auxiliary fields near the Bagnell end of the lines were used when mapping was being done in that territory. The crew usually consisted of the pilot, mechanic, locating engineer, camera man, and an extra engineer. This was more than necessary, but the plane

THE PLANE AND ITS CREW

had ample capacity and it was thought best to have plenty of help at hand.

### A TYPICAL FLIGHT DESCRIBED

In order to get the best photographic results, it was necessary to choose days for flying when the sky was clear or when there were very few clouds, and to operate between 10:00 A.M. and 2:00 P.M.

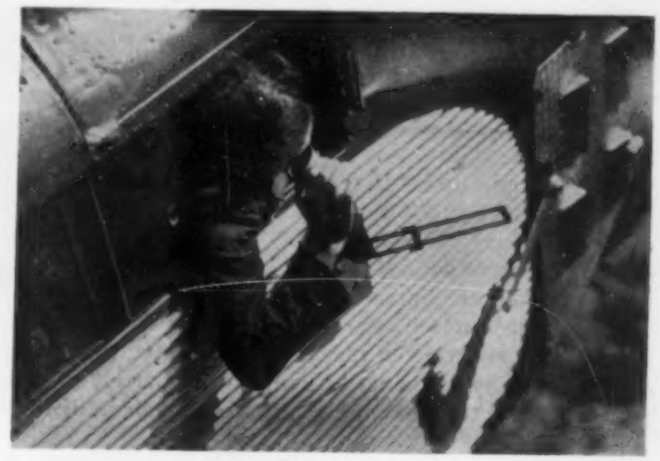
Before starting from the field, the venturi tube was connected with the camera, the altimeters set at the elevation of the field, and the camera mount placed in position. During the flight from the field to the area to be photographed, the camera was loaded, adjusted for timing exposure, and set in the mount ready for operation.

When the plane arrived at the point where pictures were desired, a preliminary flight was made along the line indicated on the flight map to enable the pilot to pick up landmarks which were near the proposed line and to establish the approximate elevation noted on the flight map at which he should fly the plane to maintain the correct distance above the ground. At the same time, the locating engineer made observations to determine the ground speed of the plane, as well as its drift and compass bearing. After this information was secured, the plane went back to the starting point and flew down the line again. At this time the first reel was exposed.

To insure accurate mounting of the pictures and to facilitate the use of the stereoscope, the exposures were made at such intervals as to give a 66 per cent overlap on the pictures. This meant that, with the plane flying at 90 miles an hour, an exposure must be made every 7 sec., and thus a strip of territory approximately 3,600 ft. wide and 17 miles long was photographed in from 10 to 12 min. The lens of the camera was always used at its full opening of F 4.5 and the average time for exposure was $^1/_{220}$ sec. To give the correct scale of 400 ft. to 1 in., the 30 cm. lens required that the plane be kept 4,720 ft. above the ground. This height above the ground was maintained by barometer as nearly as possible.

After the first reel of film had been exposed, the plane made a preliminary flight over the next section to be photographed while the camera man was removing the exposed reel and installing a new one. The plane then returned to the beginning of the second section and the second reel was exposed. The work continued in this way until the operations outlined for the day had been completed. A complete record was made of each reel of film including its number, the section of line covered, and the timing. A record was also made of each flight, showing the atmospheric condition, and the number of hours in the air.

Three or four hours in the air is a very hard day's work,

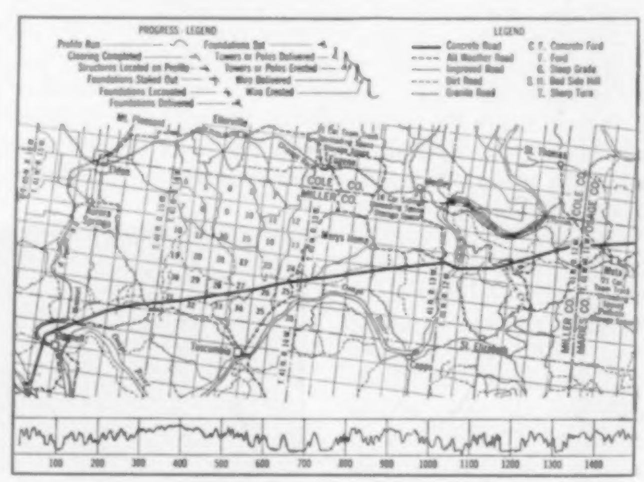


DRIFT AND SPEED INDICATOR

but when it is considered that from 30 to 75 miles of line have been covered it is readily seen that the results accomplished are considerable.

### OFFICE WORK SIMPLIFIED

When developed, the exposed films were numbered

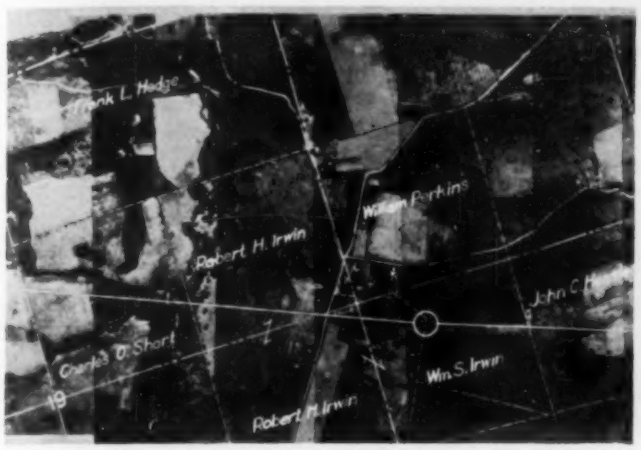


GENERAL MAP AND PROFILE
Original Scale, 1 in. = 4,000 ft.

consecutively and two sets of contact prints on single-thickness paper were made. One set was mounted in sequence on stiff manila paper cut into 18 by 42-in. sheets for convenience in handling and filing. The pictures were mounted by the three-point method, which

was considered the easiest to follow and at the same time the most accurate as regards alignment of pictures along the line of flight. With the photographs mounted, the section lines were then drawn on the sheets. This was done by obtaining as a starting point some outstanding landmark which showed on both the pictures and the maps.

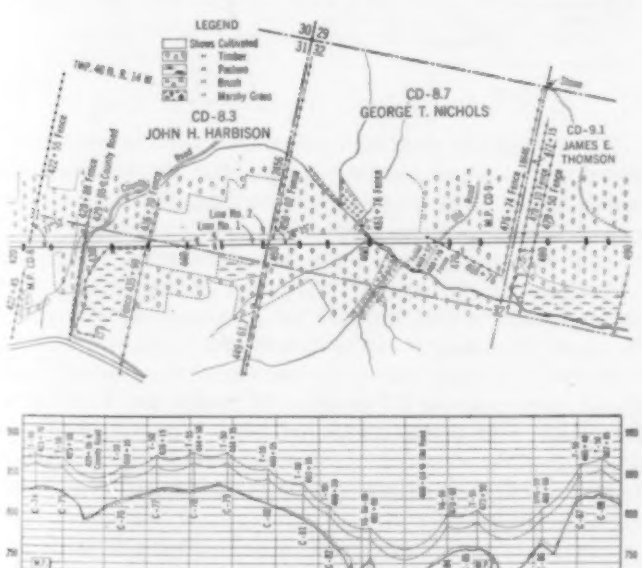
After the section lines were drawn in, the mounted sheets were compared with the maps which showed the location of the proposed lines, to see if the flight was on line. The sheets were then joined on a long table to show a strip of territory from 12 to 20 miles in length. The line was projected on the mounted pictures by pulling a string across them on the location shown on the maps and




An 11 by 14 Inch Field Print

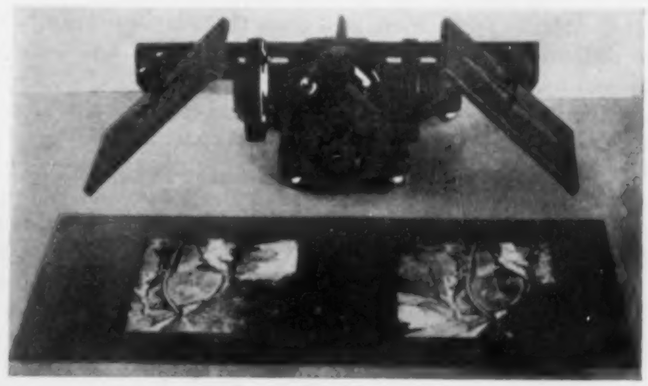
then swinging it to one side or the other in order to miss buildings, orchards, and other obstructions which appeared on the maps.

Wherever a study of the topography was desired, a stereoscope was used. All angle points were carefully




A Standard Profile and Right-of-Way Map

scrutinized in this way and were shifted when necessary to put them on suitable ground. A stereoscope examination was also made of railroad, highway, creek, and river crossings to see if they were suitable. After these controlling points had been studied, the entire line was examined for bad hillsides or other undesirable conditions which might be encountered. The use of the stereoscope, next to the mounting of the pictures, was really the most important part of the office procedure. With



Stereoscope for Binocular Study of Prints

its assistance, the line was located in the best possible place.

### RIGHT-OF-WAY SELECTED FROM PHOTO-MAP

After the line had been definitely located on the photomap, it was put in final shape for use in the field by both the right-of-way men and field parties. The first step was to provide the right-of-way department with the location of quarter sections so that it could secure property ownerships. While this was being done, section corners were being checked in the field to make sure that no serious error had occurred in locating them on the photographs. The center line of the proposed transmission line right-of-way was drawn in and the names of the property owners, together with their property lines and the section lines, were added.

It will be remembered that the sheets upon which this work had been done were 18 by 42 in., and so were too cumbersome to be used in the field. The next step was to put these maps into convenient form for the field men. This was accomplished by blocking off the sheets into rectangles of approximately 10 by 13 in. and making individual photographs of each block in order to give a continuous series of prints on the same scale as the original pictures, each print covering a distance of approximately one mile of line.

Before the sheets were photographed, care was taken to eliminate appreciable errors in scale due to any incorrect altitude of the plane. The section lines, as marked on the pictures, were compared for length with the Government township plats. If the distances on the photographs did not check with the Government township plats within 1 per cent, the rectangular blocks were ratioed to such dimensions as to give the correct scale when photographed on a standard-size negative. The final step was to reduce these 18 by 42-in. sheets by photographing them on 11 by 14-in. negatives for use in the field.

### GROUND FIELD WORK

Three prints of each negative were made, two of which were given to the right-of-way men and one to the field

party which was locating the line on the ground. Up to this time no engineering parties had gone into the field, other than to check a few section corners, and none did so until after the right-of-way had been purchased. This made it unnecessary to obtain permission to cross a man's land for surveying purposes. The fact that no engineering parties had been in the field made it easier for the right-of-way men, as it gave them an opportunity to deal with the owners before any excitement had been caused by ground surveys.

In using the aerial maps for right-of-way purposes, a special clause was inserted in the easement as follows:

> An aerial survey of said proposed transmission line has been made and a preliminary center line of said right-of-way has been approximately located by said aerial survey. A plat establishing the location of said right-of-way center line covering the easement herein granted, over and across the above-described land, will be filed in the Office of the Recorder of Deeds of said County, and said right-of-way center line shall not thereafter be changed without the consent of the Grantor.

The engineering party which took the field after the right-of-way had been secured was furnished one set of the 11 by 14-in. prints. On this job a transit party was organized to do nothing but locate on the ground the lines shown on the aerial map. It was somewhat difficult to do this in some places exactly as shown on the prints because of heavily wooded areas, but there was not enough deviation to cause any difficulty. The transit party was followed by a level party to run profile levels, and also by a land-line party which located the land corners necessary to tie in the lines as finally located.

This information was finally brought together on a set of maps and profile sheets. It was found that the pictures were invaluable in checking notes and supplying details in these final maps, which were on a scale of 1 in. = 400 ft. The profiles were plotted on a horizontal scale of 1 in. = 200 ft., and on a vertical scale of 1 in. = 20 ft.

Although the field work has not been completed for both lines, the results obtained from the aerial surveys to date have been most satisfactory. In four and a half months about 250 miles of aerial surveying and location have been completed. This was done in a total flying time of about 30 hr., a part of which was used in making preliminary flights. They were made to produce a map on a scale of 1 in. = 1,000 ft., across a part of the country where there were no good county maps available.

In three months the right-of-way men were able to purchase 140 miles of right-of-way; there are only a few owners with whom they have not closed. The right-of-way agents said that the pictures reduced their work by at least 50 per cent.

With the mounted pictures available, the engineers had at their command all of the informaton necessary for the special river and other crossings. A few changes had been made in the lines, and it was found that, with the aerial maps, it was easy to make any change desired without going into the field for further information. In about 70 miles of line which had been checked by ground surveys, it was found that the error of the aerial survey for distance was about 1 per cent. This error seemed to be cumulative but no effort has been made to correct it. In fact, it is as close as will be normally guaranteed by other aerial methods.

From our experience on this survey, the method which we employed seems to be capable of general use by engineers on work of this kind. We did all of the work except operating the plane and developing the pictures. There are, of course, numerous details which will be learned only by experience, but there is no reason why an engineer cannot run an aerial camera as well as he can run a transit. We now have as much confidence in the ability of the camera to secure reliable information as we have in a transit. We found it much easier, quicker, and cheaper to go up and make an aerial survey than to use ground surveying methods.

In this method, accuracy depends a great deal upon the barometer, but as most of the troubles with a barometer are due to the time involved between readings, the high class altimeters used on the plane will indicate with a small degree of error during the short time that the plane is in the air. They, of course, are checked each time on landing, the elevation of the landing field being known.

The methods and equipment used were not complicated; every effort was made to simplify them. However, every care was used in carrying out all the different parts of the work, and this required the very fullest cooperation between the engineers, pilot, and photographer. From our experience here, we see no reason why engineers cannot make their own aerial surveys, adopting whatever methods the results desired require.

COMPARISON OF COSTS OF AERIAL SURVEYS PER MILE OF LINE

| | With Direct Contact Prints | | With Enlarged Prints and Ground Controls | |
|---|---|---|---|---|
| Flying: | | | | |
| Preliminary maps | $1.50 | | $1.00 | |
| Flying | 4.25 | | 15.00 | |
| Camera and equipment | 2.00 | | —— | |
| Films, developing, prints, etc. | 9.25 | | —— | |
| Crew | 0.50 | $17.50 | —— | $16.00 |
| Office and field: | | | | |
| Checking section lines | 8.50 | | 8.50 | |
| Ground controls | ... | | 6.50 | |
| Mounting pictures | 1.50 | | 1.75 | |
| Marking section lines, property lines, locating lines, blocking mosaics, etc. | 13.00 | | 13.00 | |
| Mosaics or prints — 4 sets | 6.00 | $29.00 | 47.25 | $77.00 |
| Total | | $46.50 | | $93.00 |

The cost of the method used on this job has been compared with that of another method usually followed, in which the photographs were taken from an elevation to give a smaller scale of, say, 600 ft. to the inch, no particular care being used to keep the plane at a definite elevation. Each negative was then placed in a reproducing machine and brought up to a scale of 400 ft. to the inch, or whatever working scale was desired. It was necessary in this method to measure ground controls about every two or three miles to make the correction for scale. The prints which had been brought up to the working scale were then mounted on sheets, called a mosaic, and the mosaic was in turn photographed to supply working prints.

This method has two great disadvantages apart from its cost. First, it does not give direct contact prints at the working scale for examination by the stereoscope; and second, it requires two reproductions, each reproduction causing the loss of sharpness and detail. Moreover, its cost is practically twice that of the method we used. A ground survey to furnish as much information would probably have cost at least three times as much.

# Terminals on Inland Waterways

*River and Rail Facilities Meet on the Mississippi River*

By Walter F. Schulz
Member American Society of Civil Engineers
Consulting Engineer, Memphis, Tenn.

*Water transportation has long been an economical method of handling freight to territories adjacent to waterways. But on the Mississippi River, the fluctuating stages of the water surface and the resulting variations in the locations of the unloading points at the water's edge, necessitate both costly terminal construction and expensive handling of commodities. Mr. Schulz points out that the operation and maintenance cost of the terminals of the Government-owned Federal Barge Line amounted to nearly 40 per cent of the gross income in 1928. This article, abstracted from his paper read before the Inland Waterways Division, on October 2, 1930, at the St. Louis Meeting of the Society, should prove of value to all interested in inland transportation.*

It is probable that the subject of terminals on our inland waterways is more involved than is immediately apparent. This is primarily because such terminals must differ radically from those of railroads and ocean ports. Yet the problems are perhaps similar in their economic aspects for here, as in other terminals, the cost of interchanging commodities is by far the major portion of the operation cost per ton.

In the case of river terminals, the cost of transferring freight between different types of carriers has greatly offset the savings effected by the cheaper water haul. For example, in 1928, the Inland Waterways Corporation, commonly known as the Federal Barge Line, spent 39.3 cents out of every dollar received from all sources, on the operation and maintenance of terminals variously located on the Mississippi and Warrior Rivers. Although this cost of terminal operation and maintenance has steadily decreased from year to year, the fact remains that it is of sufficient magnitude to warrant continuous study and thought, with a view to decreasing it and thus making available increased sums for other items, such as new and better equipment.

## COMMODITY HANDLING COSTS STILL HIGH

Competent observers have said that during the past two decades great strides have been made in solving the problem of production in industry. Production costs have been greatly reduced through unit production, machinery, and increased labor efficiency, but there has been a tendency, perhaps, to lose sight of problems relating to distribution. This is true not only of the distribution scheme, but also of the various methods of handling commodities while they are in process of distribution. Certainly the same thought and effort has not been directed to distribution which has been so thoroughly applied to production.

Every phase of business deserves the careful attention that production has enjoyed, for the gains made in one branch of industrial development may easily be lost in others. Long chains of handling, seemingly necessary, between production and consumption offer opportunity for analysis, which may result in savings equal to those accomplished in the production field. In many cases, the distribution cost exceeds production cost.

It is a basic condition of railroad operation that the capacity of a railroad is limited by the capacity of its terminal facilities. In other words, it is uneconomic to move tonnage trains at comparatively high speed if, upon arrival at destination, they cannot be expeditiously and economically handled. The same theory applies to common-carrier, barge-line operations.

Coming to the specific problem of river terminals, I shall discuss here only the terminals of the Federal Barge Line, as at present this line operates the principal modern terminals on the Mississippi and Warrior Rivers, and, according to reports, will in the very near future extend its operations on the Illinois River and the lower Missouri Rivers.

On the present Federally owned barge line, the general practice is that barges, towboats, and other operating equipment are constructed and owned by that line, while, with but five exceptions, the terminals are owned by the municipalities. This makes virtually for public ownership of both floating and fixed facilities, and such ownership is based on well considered reasons.

The day will come when the now Federally owned barge line will be but one of many privately owned lines, for the commitment of Congress is very plain that Federal ownership will be retained only through periods of preliminary operation and demonstration, and until the whole project is on an economical basis. When Congress elects to sell any or all of its barge lines, they will unquestionably include all of the equipment and facilities of each division, as well as the leases on the municipally owned terminals.

## PRIVATELY OWNED LINES

Even now, other privately owned barge lines are using the municipally owned terminals in common with the Federal line. The establishment of these other lines is rightly based upon expectations of being able to use the existing terminal facilities, because terminals must be built to handle freight at low unit costs and can, therefore, handle daily thousands as readily as hundreds of tons. Sale of these municipal terminals to a private barge line would unquestionably mean their closing to other competitive lines. The result would probably be the freezing out of the latter and the subsequent fall of the former under the burden of heavy terminal operation and maintenance costs, if assessed against its operations alone. For these reasons it is the general belief that each city should retain that control over its terminal facilities which comes only from direct ownership.

Another question that arises time and again is the economic desirability of city ownership of terminals of such size and type as will enable interchange of river and rail freight to and from points outside the city by rail. This is not only desirable but is an economic necessity. A river terminal built to handle freight at unit costs low


MINNEAPOLIS RIVER AND RAIL TERMINAL

enough to permit of the retention of the lower river rates must be built to perform certain functions. The cost of facilities able to perform these transfer operations at low cost is practically fixed, as far as initial investment and carrying charges are concerned. Within certain limits, these costs are practically constant, regardless of the tonnage handled.

The Federal Barge Line usually leases municipal river terminals on the basis of the payment to the city of a fixed sum, derived from fixed charges, or so much per ton for all freight passing through. Therefore it behooves each city to attract tonnage to its terminal in order to increase the revenue from which its fixed charges must be met.

### SEPARATE TERMINALS FOR GRAIN, BULK, AND PACKAGE FREIGHT

Broadly speaking, the kinds of freight which have been handled over river terminals operated by the Federal line are identical with those carried by railroads, and may generally be divided into two classes, bulk and package products. The bulk commodities usually consist of ore, pipe, bars, structural shapes, and other heavy materials handled in a similar manner. Grain, of which there has been considerable volume, of course requires special facilities. But the package commodities are many and of various sizes, shapes, and weights. Consequently, the problem is how to develop handling facilities which are elastic enough to permit of economical handling, regardless of the type of commodity. Where a package commodity moves in large and fairly constant volume, special and separate facilities have been provided at important gateways.

Traffic varies considerably in character both from season to season and from section to section along a river of the length of the Mississippi. On the Warrior River, however, the class of freight is fairly constant. The Federal line operates on the Mississippi River from the Twin Cities to New Orleans, a distance of 1,839 miles; on the Warrior from Mobile to Birmingham, 419 miles; and from New Orleans to Mobile via the Gulf, a distance of 150 miles.

After the establishment of a site, the terminal problem is threefold; first, to develop facilities that will economically handle the various kinds of commodities, which will pass through the port in question; second, to


BURLINGTON RIVER AND RAIL TERMINAL

adapt these facilities to the various horizontal and vertical ranges of the river; and third, to connect these facilities with dock and house tracks, as well as with common interchange yards directly connecting with all rail carriers.

### VARIABLE RIVER STAGES AND BANK LOCATION COMPLICATE TERMINALS

In so far as terminals on the Mississippi River are concerned, the variations in the widths of the river at extreme low and high water must be reconciled with the variation of vertical distances from zero to 60 ft. At Memphis, the vertical variation becomes 50 ft. with a horizontal difference of about 200 ft., even on the famous Chickasaw Bluffs. On the Arkansas side the Father of Waters spreads itself several miles before encountering levee resistance.

At Helena, the vertical variation increases to 60 ft., and the horizontal distance from the low-water channel to the site permitted for any structure becomes 300 ft. On the lower river the situation is simply this—if any construction with a fixed location is designed to meet the conditions imposed upon it by low water, at high water it will be a menace to navigation, and it will be seriously endangered by the flood stages. In fact it would often be in the channel at the higher stages. Conversely, were the facilities constructed for use during normal stages, operation would necessarily be suspended at lower stages.

At Minneapolis, the existing terminals are located on a pool stage, created by a dam between the Twin Cities, and are subject to a rise of only 10 ft. during the spring floods. The terminals at St. Paul were built at a time when the variation between extreme high and low water was approximately 20 ft. However, since the construction of the Hastings Dam, some 20 miles below, a pool has been forming alongside the St. Paul terminals, and within a short time the condition there will be directly analogous to that at Minneapolis. At Burlington, the extreme vertical variation is 14 ft., while at Dubuque, Rock Island, and Quincy, it is about 20 ft.

Up to this time, terminals of three general types have been constructed to meet the various river and traffic conditions. The first of these is referred to as the merchandise or package terminal; the second is the direct rail-to-barge interchange terminal; and the third, the bulk terminal. In addition, special facilities are provided for the handling of grain, which are necessarily separate from the rest of the terminal, but must be made to function as a part of the ultimate layout. Terminals for single commodities, moving in large volume, are of special design and usually a modification of the first and third types.

### PACKAGE FREIGHT TERMINALS

Merchandise, as offered and received by the shippers of the valley, must be accepted in containers that meet the approval of the railroads and cannot satisfactorily be handled on open wharves. This means that some form of covered conveying system to raise or lower freight, at any stage of the river, from the cargo barge to the dockhouse located above high water, must be designed and employed. The best that has been developed so far is a covered, mechanically operated escalator to convey four-wheel trailer trucks from one level to the other unattended.

The upper Mississippi River terminals are generally similar in type and are more modern than those on the lower river. They ordinarily consist of a steel wharf barge permanently moored in front of the terminal with an escalator, adjustable to changes in the river, leading to the dockhouse above. This dockhouse has an area used, as is a local railroad freighthouse, for merchandise in transit. It is adjoined by railroad tracks similar to those at a railroad freighthouse.

### ALL-STEEL CARGO BARGES

The cargo barges, which have now been standardized, are of all-steel construction, double skinned, with a housed-in superstructure for the full protection of cargo from theft and from the elements. These barges are divided into vertical compartments with between-decks and side doors equidistant from each other. The wharf barge has its doors spaced to come directly opposite those of the cargo barges moored alongside. When a barge of package merchandise arrives, all of its compartments are "broken open" and four-wheeled trailer trucks are run directly into it for loading with bags of sugar, for example. The bags in one compartment are for immediate local delivery, those in another for warehousing in transit, while still others may have cargo for immediate forwarding to various points by rail.

Loading of the trucks is carried on simultaneously in all compartments, and each truck is tagged with its immediate destination—the local freighthouse, section X of the warehouse, or car 43,918, which has been spotted for the load to Little Rock. As they are loaded, the trucks are pushed across the wharf barge to the foot of the escalator, where they are fed to the endless chain conveyor to be hauled, unattended, to the dockhouse above. Arriving there, they are sorted into "trains" and hauled to the freighthouse, the warehouse, or the cars.

While this is going on, the empty trucks are brought back to the head of the returning escalator, and conveyed back to the cargo barges for reloading. Sometimes it happens that the cargo barge is being loaded up with merchandise from the terminal at the same time that it is being unloaded and, in such cases, the returning trucks are loaded with outbound freight.

### ESCALATORS ON UPPER RIVER

On the upper river, the escalators are suspended at the river end in a gallows frame, which, by means of a push-button control, enables the entire escalator to be instantly raised or lowered to the desired level. At the upper or land end, a contrivance has been developed to keep the floor of the escalator level with the floor of the dockhouse. At this point there are three movements to contend with, rotation, and horizontal and vertical translation. These three movements have complicated the problem at this point, but the solution has been found in an ingenious device. Of course this type of escalator requires permanently fixed piers at the river end for the erection of the gallows frame and for this reason cannot be used on the lower river.

On the lower Mississippi the same general type of es-

Trucks Moving on Escalator
Burlington River and Rail Terminal

Freight Moving up Incline
Memphis River Terminal

calator is used except that it is connected to the wharf barge at the lower end by wedge-shaped structures, known as cradles. These run up and down the tracks of a fixed incline, and are readily adjustable to any stage of the river. With this slight modification, the merchandise terminals on the lower river are similar to those on the upper river. The maximum grade adopted for covered escalators is 25 per cent, and their length is dependent on the extreme variation of the river during the navigation season.

BATON ROUGE BULK FREIGHT TERMINAL
Direct Barge-to-Car Transfer

Dockhouses on the upper Mississippi are usually of fireproof construction, 100 ft. wide, and of variable lengths. Offices for traffic and terminal employees are provided together with ample rest facilities for the stevedores.

BULK FREIGHT TERMINALS

At points on the Mississippi, and also on the Warrior River, a number of special terminals have been constructed for the handling of steel and other bulk products directly from barge to car, or car to barge. These terminals generally have cranes or derricks operated on, or adjacent to track facilities immediately alongside the channel, and are most excellent for their particular purpose. They are, however, most emphatically not suitable for the handling of package freight, because such freight, if picked up in slings, becomes badly damaged, and many claims for losses result.

Other methods have been tried, such as using trays or "skips" into which the freight is loaded on the barge and hoisted to the dock above, where it is removed to trucks or other conveyors to be taken to the freighthouse, warehouse, or cars. This method has proved generally unsatisfactory because its operation has been limited to pleasant weather. It is obvious that the top hatches of barges cannot be opened while it is raining if the goods to be hoisted out are subject to damage from the elements. Further, it is less economical than the escalator system, because of the cost of rehandling the freight for conveyance from the barge to the freighthouse, warehouse, or cars.

The bulk terminals on the upper Mississippi usually consist of treated pile and timber trestle docks or quay walls of steel piling with earth fill, the outboard face being parallel to the current at a depth of 9 ft. The wharf is provided with two railroad tracks for open-top cars and the operation of locomotive cranes. Capstans are also provided for maneuvering the barges along the terminal front without the use of a towboat or tug.

DIRECT-TRANSFER TERMINALS

At Vicksburg, Memphis, and Cairo, on the lower Mississippi, and at East St. Louis, where the tonnage moving on a joint river-and-rail routing is large in relation to the total, terminals of the direct-transfer type have been devised and constructed. This type, usually referred to as an interchange terminal, consists of a double-track railroad trestle, constructed on a $3^1/_2$ per cent grade, parallel with the bank, and extending from the level of the railroad yards above, to below extreme low water.

Car floats, either of steel or concrete, with three tracks, are connected to these inclines by means of timber cradles very much as trains are now transferred across the Mississippi at New Orleans, Baton Rouge, Natchez, and Helena. With the rise and fall of the river, the cradles are rolled up and down on the tracks of the incline by means of a locomotive, so as to keep the decks of cradles and car floats just above the level of the water. They are so constructed as to permit switching movements down the inclined trestle, over the cradles, and onto the car floats at a speed of about ten miles per hour. The inclined trestle, cradles, and car floats are designed on the basis of Cooper's E-60 loading.

At Memphis, the interchange terminal has two steel car floats holding 36 cars, connected in tandem by means of connecting swinging beams, as shown in the illustration. Along the outboard side are moored two covered concrete transit barges, which act as a floating wharf. Adjustable gang planks are provided at each outboard door to take care of the cargo barge displacement, which varies 6 ft. between empty and full load.

This type of terminal permits direct trucking under cover from the cargo barges to cars or vice-versa, which, so far, has produced the lowest terminal operating cost. Sufficient tonnage, however, must justify the initial expense of construction. The extreme horizontal movement, parallel with the river, of the car float and transit barges at the Memphis terminal is about 1,400 ft. This extreme movement rarely occurs in a single year. The car floats are held in alignment by pile clusters. Rail interchange yards with direct connections to all rail lines are required with this type of terminal.

HANDLING BULK TONNAGE AT MEMPHIS

At Memphis, where the bulk tonnage, such as coal and steel, is very large, special terminals have been provided by private corporations, which, in most cases, also operate their own river equipment. There are now seven such private steel companies transferring bulk steel products from barges directly to storage or to railroad cars for immediate shipment. The largest portion of this tonnage is steel pipe, manufactured in the Pittsburgh district, moved by barge to Memphis, and then to the oil fields by rail.

On the Warrior River, at Birmingport, a special type of terminal has been constructed, due to the fact that all terminals are located on pool stages, subject to severe and sudden floods. This type consists of a vertical face, built of steel cylinders filled with concrete, along which

barges can be moored. Upon these cylinders and back toward the shore, a warehouse is constructed in which operates a monorail telfer system of carriers. The roof of the warehouse is cantilevered over the river so that the carriers can operate over the top of the barges, affording protection and permitting unloading or loading during inclement weather.

Barges on the Warrior River are loaded and unloaded from the top, thus commodities are lifted from the hold of the barge, and transported by the telfers directly to storage piles in the warehouse or railroad cars, depending upon their destination. The system is so developed that the carriers can run over the full length of the barge, picking up merchandise located in any part of it. A number of telfers are provided, so that the transfer operations from barge to car or vica versa is carried on continuously. Tracks are provided adjacent to the warehouse. A large power operated gantry crane is used for transferring steel and other bulk products between rail and water carriers.

### FACILITIES FOR HANDLING GRAIN

In addition to the port elevator at New Orleans, there are also elevators at St. Louis, Burlington, Davenport, and St. Paul, which have been constructed or provided with facilities for transferring grain to or from barges. Minneapolis, Cairo, and Helena have transfer facilities for handling grain direct from cars to barges. The transfer plants at Cairo and at Minneapolis are of a temporary nature. At Helena, however, a transfer plant has been constructed which will serve as a unit of the ultimate grain transfer terminal A feature of the Helena plant is its mooring facilities, which are of a permanent nature, having been sunk some 40 ft. below the existing bed of the river.

The problem of extreme vertical and horizontal variation is particularly evident at the Helena terminal, where the grain travels a horizontal distance of approximately 600 ft., and the end of the belt from which it is discharged is approximately 100 ft. above extreme low water. This plant was only recently put into operation, and with the existing river stages, it was immediately asked to function at extremely low water.

At Davenport, the grain-handling facilities constructed by the International Milling Company, were placed in operation during this season and provide for both loading and unloading, in addition to a large amount of storage space.

### SELECTION OF TERMINAL SITES IMPORTANT

Generally speaking, the location of a river terminal is determined by three factors, which are sometimes realized by its advocates, but are seldom considered in the order of their proper relative importance. Any location must be examined, first, from the standpoint of navigation; second, from that of existing and proposed railroad or other transportation facilities; and third, from that of the availability of sufficient and suitable space for the initial as well as the ultimate development of the terminal.

Of these considerations, the first includes the location of bridges and their effect upon any proposed site; the effect of the current in the river; whether or not the bank is protected, and gives some indication of permanence as to its location; whether the formation of ice occurs and, if so, to what extent; and the vertical and horizontal variations in the river's stages.

Seldom is proper consideration given to the second factor. Early and faulty rail set-ups are largely responsible for the present high terminal expense. River traffic can function only haphazardly unless it is efficiently coordinated with rail transportation. Interchange provisions with the available railroads in the city, especially those serving the local industries and important hinterland areas, must be provided for.


Memphis Barge-to-Car Interchange Terminal
Wharf Barge and Car Float

Availability of sufficient space, the third consideration, includes a determination of the sum economically justified for the purchase of property at any particular location. Almost all terminals constructed by municipalities along the Mississippi have cost from \$230,000 to \$500,000; although such cities as New Orleans, St. Louis, and Memphis have developments costing far in excess of these amounts. However, the fact remains that the amount of money which can be economically expended for the acquisition of property is decidedly limited.

### PROBLEM GROWS MORE COMPLEX

In conclusion it may be said that the location and construction of river terminals is now a more complicated problem than it was when the Federal Barge Line was started. Experience gathered during the 12 years it has been in operation has established certain precedents as to profitable and unprofitable design and operation. This has been brought about by elimination of the unfit and selection of the best proven facility for each type of handling. Sound economics should prompt full consideration of the factors thus established, and the future development and extension of the Federal Barge Line service should be prefaced and accompanied by qualified study of each general and local problem as it arises to be solved.

Common-carrier, barge-line service, as conducted by the Federal Government, is an experiment. The Secretary of War is authority for the statement that, if and when this type of transportation proves economically justifiable, the Government barge lines will be for sale to private interests for operation.

# Flood Control Studies in the Mississippi Valley

CORPS OF ENGINEERS ADAPTS TWO SURVEYING AND MAPPING METHODS

*NOT only is water one of mankind's necessities but it may also become his greatest curse. Many millions of dollars of damage has been done by the floods of the Mississippi River and its tributaries. The first step in determining how to control, direct, and harness these floods, is, of necessity, to make a comprehensive study of existing physical conditions. Major Worsham relates how legislation is enabling the War Department to prepare flood-control plans for all the streams of the United States, and explains in detail the work on the Arkansas and the White Rivers. Mr. Clemens discusses the advantages of ground-controlled aerial photography as applied to the Red River Valley. These papers, here abstracted, were read on October 3, 1930, before the Waterways Division, at the Society's St. Louis Meeting.*

# Arkansas River Mapped by Ground Methods

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SURVEYING and mapping in connection with the preparation or execution of any flood control plan are for a special purpose. Unless this fact is kept constantly in mind, large sums and much time will be wasted in preparing general purpose maps. In order to foresee clearly what is essential and what is non-essential in these special-purpose surveys, the flood engineer must have clearly in mind the four stages in the development and execution of a flood control plan: investigation, preparation of the general plan, preparation of details of the plan, and finally the construction stage.

In describing the topographic data necessary and the means of securing it, during the stages of developing and executing the plan, it must be remembered that there are other phases of the problem requiring much data on economics and stream flow, which must be secured from records or from the field before a general or detailed plan can be prepared.

### PERSONAL RECONNAISSANCE FIRST STEP

An investigation must first be made to determine whether the floods on the stream under investigation are of sufficient magnitude, frequency, and severity with respect to damage to warrant the cost of preparing the general plan. In this investigation, general purpose maps such as the U.S. Geological Survey topographic sheets and county maps are used in making a personal reconnaissance.

Instrument surveys are started as soon as the investigation has proceeded far enough to show clearly that the problem is of sufficient magnitude to justify the cost of preparing a general plan. The engineer in charge of issuing instructions to the survey parties must have a knowledge of certain fundamental principles of flood engineering in order to secure only essential data. He must know that the usual methods of controlling floods are by levees; by levees and reservoirs (reservoirs alone are rarely adequate or economical); by diversion; and, occasionally, by special treatment at certain localities, involving channel straightening and enlargement; or by a combination of the above methods. He must also know that discharge data, particularly those of maximum flow, are usually deficient or entirely unobtainable, and certain field data must be secured to supplement the published information.

### GENERAL PLAN REQUIRES FIELD SURVEYS

With these principles in mind, the additional information to be obtained from the field for preparation of the general plan consists of:

1. Extent of overflow area, and depth of overflow
2. Data to determine general levee locations and levee yardage
3. Information to supplement discharge records
4. Determination of possible reservoirs with height of dam and capacity of reservoir
5. Special surveys where diversion, channel straightening, or enlargement seems advisable.

After determining the general plan which provides the most economical and effective solution, and if funds are available for its execution, the next procedure is to prepare the detailed plan. The detailed plan requires field data from which levee construction contracts can be prepared, necessitates investigation of foundation conditions in various levee and dam locations and ascertaining the owners of the right-of-way required.

### APPLICATION TO MISSISSIPPI RIVER

These various stages in the development and execution of a flood control plan have been applied to the Mississippi River flood problem and then to its tributaries. After the great flood of 1927, the Chief of Engineers was called upon to present to Congress a comprehensive plan for the control of the floods of the Mississippi River. Reports on the stream dated back to 1853 and the Missis-

sippi River Commission has been collecting data and making surveys since 1879. The information available was sufficient to compare its effectiveness and cost of various plans and to prepare the best general plan which involved the use of levees and diversions. This plan was


TYPICAL LAND CAMP, WHITE RIVER SURVEY
Augusta, Ark.

adopted by Congress and funds were made available for its execution.

### MEMPHIS DISTRICT ORGANIZES FOR THE WORK

Preparing the detailed plan for the control of the Mississippi River floods required a great amount of field surveying. To illustrate the type of surveying done in this connection, I will describe that done in the Memphis Engineer District, which is typical of similar work in the districts engaged in flood control work from Cairo to New Orleans.

The District Office at Memphis is divided into several divisions and sections. The planning and technical supervision of all surveys within the district is a duty of the Survey Section of the General Engineering Division of the District Office. The Survey Section prepares detailed instructions for all survey operations except those for construction operations, which are prepared by the head of the particular section of the Operations Division under which the construction work is to be done.

The territory embraced in the Memphis District is divided into four geographical areas, three along the Mississippi and one, of which I am in charge, including all the tributaries from Cairo to the mouth of the Arkansas River. The field work for surveys needed in preparing the detailed plan is under the supervision of the engineer in charge of each field area.

### SURVEYS FOR DETAILED PLANS

One of the most important surveys of this character was that covering the Birds Point—New Madrid Missouri floodway. Here a careful topographic survey and map, with scale of 1:10,000, was made covering approximately 200 sq. miles. Cross sections were taken normal to the direction of flow at intervals varying from one-half mile to a mile. In one critical location, 1-ft. contours were taken. Relocations were made of drainage ditches, where these were interfered with by the new set-back levees.

Levee control-line surveys were run to provide an accurate map of the levee system, and of the river and flood plane in order that data might be on hand not only to show the exact location and elevation of existing levees, but also to furnish information needed in considering such details as set-backs and levee loops. The field work for this survey is under the close supervision of the engineers in charge of the field areas; it is they who are responsible for seeing that the location and construction of levees are in accordance with approved plans.

The horizontal and vertical controls are based on those of the Mississippi River Commission. The main control traverses follow the levee and are taped; angular measurements are made by the "double deflection angle" method, with computed azimuths; and azimuth observations are taken at intervals not exceeding ten miles. All measured courses are checked by stadia. The error of closure for taped traverses must not exceed 1 in 5,000. The vertical control consists of wye-level lines of the third order following the lines of control traverse and closing with an error of less than 0.05 ft. times the square root of the length of the circuit in miles. Stadia traverses for topography taken along sections extending outward from the levee lines at one-quarter mile intervals, for distances of from one-half to one mile landward of the levee, may be taken with a transit or plane table, whichever is best suited to the particular locality. Where these traverses are closed, the error of closure must not exceed 1 in 500 for position, and 0.5 ft. for closure. The scale of this work is 1:10,000.

### REVETMENT SURVEYS

In some localities, due to varying conditions, it is impossible or uneconomical to set back from the river levees that are endangered by caving banks. In such cases it is necessary to stabilize the bank by revetment. The survey of existing revetments and of caving banks is done by a single survey party organized by the District Office and under the engineer in whose field area it is working. Its purpose is to determine the condition of existing revetments and other channel structures and the location and rate of progress of caving banks. This party, consisting of 20 men, is directed by a competent engineer who has, through several years experience, a thorough knowledge of the location of all subaqueous structures as well as of all permanent marks along the banks. The party is provided with a launch and quarter boat, and takes soundings along ranges, normal to the shore, across existing revetments, and in localities where new work seems necessary. Identical ranges are used each year. All soundings are plotted on a scale of 1 in. = 50 ft., horizontal and vertical. Sufficient shots are taken both above and below the revetment or caving bank to delineate the bank line on a scale of 1:5,000.

### CONGRESSIONAL ACTION INITIATES STUDIES

At the present time, the Corps of Engineers is engaged in making a comprehensive study and evaluation of the water resources of the most important streams of the entire United States, with the exception of the Colorado and Sacramento Rivers. This is probably the greatest river study of all time. A résumé of the legislation that led up to this great study will indicate the magnitude of the problem and emphasize the necessity for a carefully planned investigation to precede the preparation of plans.

Section 3 of the River and Harbor Act of March 3,

1925, directed the Secretary of War, through the Chief of Engineers and the Federal Power Commission, to prepare a plan and estimate the cost for "...investigations...with a view to the formulation of general plans for the most effective improvement of such streams for the purpose of navigation, and the prosecution of such improvement in combination with the most efficient development of potential water power, the control of floods, and the needs of irrigation...."

The streams numbered 183, and with their tributaries drain practically the entire United States, except the basins of the Colorado River and the Sacramento River. The Colorado River was already under investigation by the Bureau of Reclamation and a flood-control project had already been adopted for the Sacramento. The plan and estimate called for were presented to Congress in April, 1926, and published as House Document 308, Sixty-ninth Congress, First Session. Because of the number of the House document, these investigations are generally known in the Engineer Department as "308 surveys." The estimate of cost for making the investigations was $7,322,400.

By the River and Harbor Act of January 21, 1927, the Chief of Engineers was directed to undertake these studies, and the first funds were actually made available by the War Department Appropriation Act of March 23, 1928. In the meantime, the great flood of 1927 occurred, and during the discussion of flood-control plans the belief developed in the minds of some members of Congress that a system of reservoirs on the tributaries might alleviate flood conditions in the Mississippi River. As a result, the Flood Control Act, approved May 15, 1928, contained provisions for the investigation of projects for flood control on all tributary streams of the Mississippi system subject to destructive floods, and named the Red, Yazoo, White, St. Francis, Arkansas, Ohio, Missouri, and Illinois Rivers together with all their tributaries.

In addition, this act directed the investigation of the effect of further control of the lower Mississippi River by establishing reservoirs on the tributary streams; the benefits that would accrue to navigation and agriculture from the prevention of erosion and siltage entering the stream; a determination of the capacity of the soils of the district to receive and hold waters from such reservoirs; the prospective income from the disposal of reservoired waters; the extent to which reservoired waters might be made available for public and private uses; and inquiry as to the return flow of waters placed in the soils from reservoirs, and as to their stabilizing effect on stream flow as a means of preventing erosion and siltage, and improving navigation. Through the Secretary of Agriculture and other agencies, the extent and manner in which floods in the Mississippi Valley may be controlled by proper forestry practice are to be ascertained.

Besides the $7,322,400 previously authorized by the River and Harbor Act of January 21, 1927, the Flood Control Act authorized the expenditure of $5,000,000 for the investigations ordered on the tributaries of the Mississippi. This legislation indicated that, whereas the original legislation emphasized navigation with power, flood control, and irrigation, as more or less allied subjects, the subsequent legislation rearranged the order of importance and emphasized flood control.

Reports on the Mississippi River date back to 1853, and the Mississippi River Commission has been collecting data and making surveys since 1879. The information available was sufficient to compare the effectiveness and cost of various plans and to prepare the best general plan, which involved the use of levees and diversions.

SURVEY BOATS, ARKANSAS RIVER SURVEY
Office Boat, Mess Boat, Quarter Boat

### INVESTIGATION BEGUN

A comprehensive plan for the control of floods of the St. Francis River was submitted to Congress August 7, 1929. Investigations of the White and Arkansas Rivers, Fig. 1, are now in progress and most of the survey work has been completed.

The first step in carrying out the instructions of Congress, as contained in the bills previously mentioned, was the investigation of these streams. Engineers were sent into the field to obtain by personal reconnaissance and interviews with inhabitants the extent of overflow, frequency of overflow, and amount of damage. They also collected all levee and drainage district maps and available county maps, and made reconnaissances of the streams to determine possible reservoir sites. By correspondence, the Memphis Office collected all available data not on file concerning the St. Francis, White, and Arkansas Rivers and their tributaries.

### GENERAL PLAN DATA FOR WHITE AND ARKANSAS RIVERS

One month after beginning the investigation of the White and Arkansas Rivers and their tributaries, it was evident that the situation on the main stems of these rivers and their major tributaries warranted the preparation of general plans. The organization for securing topographic data necessary for the preparation of these plans was then assembled.

Three Assistant Engineers and one Associate Engineer were assigned to tributaries of the Arkansas River and sent to the field. It was essential that trained and experienced engineers be secured, for this work required initiative, energy, resourcefulness, and sound judgment. Each of the group leaders was provided with from two to three survey parties varying in size from 8 to 30 men. Each party was quartered in camp and a chief of party was designated. There were the usual camp equipage and survey instruments, and motor equipment consisting of two 1- to $1^1/_2$-ton trucks for each camp, and a light passenger car for the group leader.

In making the surveys for the Arkansas River and tributaries, instructions were given to the group leaders to secure data for determining the best plan for flood protection, either by reservoirs, levees, diversions, channel improvement, or by a combination of these methods. Surveys of reservoirs were made for suggested details to permit of their being studied for irrigation or water-power purposes.

### DAM SITE SURVEYS

Reconnaissances were made to select the dam sites that appeared to be best, giving careful consideration to the cost of the sites as well as to the areas to be flooded. Plane-table or stadia surveys were run on the center line of probable dam sites with side shots to show sufficient topography, including bluff lines up and downstream, to insure most economical location, a width of from one-fourth to one-half mile being usually sufficient. Foundation data, such as nearby well logs, type of soil, rock outcroppings, transportation facilities, and similar pertinent facts for estimating the cost of the dam were noted. Contours on 10-ft. intervals were extended at least 10 ft. above the probable height of the dam and maps were drawn to a scale of 1:4,800, or 400 ft. = 1 in.


All Sighting Was Not Done Through Transits

### RESERVOIR SURVEYS

Reservoir sites were reconnoitered to get land classification and land values, together with improvements, highways, railroads, and other structures which would be damaged or flooded by the proposed reservoir. Where the probable height of a dam covered two or more contours on the U.S. Geological Survey quadrangle sheet, no surveys were made except to correct essential errors on the map. Where only one contour on the sheet would be flooded, one or more cross sections of the reservoir were run, or a longitudinal section along the valley floor, with spur lines to either side.

Where no U.S. Geological Survey sheets were available, plane-table or stadia traverses were made to show one contour above the probable high-water level in the reservoir, and the contour at this level. Cross sections of the valley floor were taken and lower contours were estimated and sketched in. The topography of possible natural spillways upstream from the dam section was also taken. For reservoir maps, a scale of 1:24,000 (2,000 ft. = 1 in.) and a contour interval of 20 ft. were selected. Plane-table or stadia maps of selected diversion routes, covering a width of about one-quarter mile, or wide enough to include the tops of necessary cuts or the location of retaining dikes, were made to a scale of 1:12,000 (1,000 ft. = 1 in.), with a contour interval of 5 ft.

### SURVEYS AND MAPS FOR LEVEE PLANS

Where surveys of river and valley floors for levee plans were made, a single stadia traverse was run through the valley. This was tied in on Government land-survey corners with side shots to show sufficient topography and river location so that the approximate location of the proposed levee could be determined. Cross sections of valley flood planes, including river sections, were taken each mile, with additional sections at bottlenecks or other critical points.

Where a valley was so narrow as to make the practicability of levees doubtful, a cross section every three miles was found to be sufficient. But in valleys too narrow to warrant the building of levees, no surveys were made except to locate by reconnaissance methods the high-water or bluff line between cross sections. Field sketching showed timber, canals, levees, obstructions such as railroad and highway fills, and the general nature of the land to be protected. Maps for levee plans were drawn to a scale of 1:48,000 (4,000 ft. = 1 in.) and elevations in figures were plotted at approximately each 1,000 ft. along the traverses or cross sections.

To compute maximum discharge, from three to five cross sections of the flood plane, including the river channel, with high-water marks at each section, if possible, were taken in a reasonably uniform stretch of river, preferably from one to two miles in length, with notes showing the regimen of the stream and the presence of brush, timber, or other obstructions to flow in the stretch selected.

The following table and explanation issued to chiefs of parties was intended as a rough guide to assist the field men in determining when to make a valley survey for levees. In general, a width of land of less than one mile that may be protected by one levee will need investigation before making surveys upon which to base levee plans. Minimum valley widths in feet between river and bluff, for the economical use of levees are as shown in Table I, on opposite page.

To use this table, assume that river-bottom land will stand a flood-protection cost of \$25 per acre. If high water marks show a flood depth of 5 ft. over that land, and if confining the flood flow between levees would increase the water elevation 2 ft., a 9-ft. levee would be required, allowing 2 ft. for freeboard. From Table I it is seen that the width of the valley from the river to the highland will have to be at least 10,170 ft. to justify the construction of a levee along the front. Similarly, a 6 ft. levee would only require a 5,035-ft. width of land, but a 12-ft. levee would require a 17,040-ft. width. Obviously, the minimum width of land required will vary inversely as the amount of the benefit to be obtained by the construction of the levee.

Field men were instructed to make no statements to persons interested in the work concerning any controversial matter but to stress the point that no decision for or against any scheme of flood control or navigation could be made until the necessary field data upon which to base a comprehensive plan had been obtained. This

avoided the unpleasant results of being misunderstood and misquoted.

### BENCH LEVELS

In the Arkansas River Valley below Tulsa, Okla., permanent bench marks were set approximately 3 miles apart, with temporary bench marks every mile. Level traverses were closed by looping, the opposite direction being run at the same time of day whenever practicable. Equalized shots were limited to a length of 500 ft. The target was set for all shots and a peg book kept with independent target readings. Circuits were tied into U.S. Geological Survey bench marks and permanent railroad bench marks. Level notes were kept with plus and minus readings only, without carrying heights of instrument, and the notes of each loop were checked in the level book and peg book independently. Bench marks were all carefully described in the notes, with sketches where needed.

TABLE I MINIMUM VALLEY WIDTHS FOR ECONOMICAL USE OF LEVEES

| Height of Levee in Ft. | Cu. Yd. of Fill per 100-Ft. Station | Cost per Ft. of Levees at $0.30 per Cu. Yd. | Minimum Width in Feet Between River and Bluff of Single Levee to Return Cost of Levee at Value Given Below: $25 per Acre Width in Ft. | $35 per Acre Width in Ft. | $50 per Acre Width in Ft. |
|---|---|---|---|---|---|
| 1 | 41 | $0.205 | 355 | 255 | 180 |
| 2 | 104 | 0.520 | 905 | 645 | 450 |
| 3 | 189 | 0.945 | 1,650 | 1,175 | 820 |
| 4 | 296 | 1.480 | 2,580 | 1,840 | 1,290 |
| 5 | 426 | 2.130 | 3,710 | 2,650 | 1,855 |
| 6 | 578 | 2.890 | 5,035 | 3,600 | 2,520 |
| 7 | 752 | 3.760 | 6,550 | 4,680 | 3,275 |
| 8 | 948 | 4.740 | 8,260 | 5.900 | 4,130 |
| 9 | 1,167 | 5.835 | 10,170 | 7,260 | 5,085 |
| 10 | 1,407 | 7.035 | 12,260 | 8.755 | 6,130 |
| 11 | 1,670 | 8.350 | 14,550 | 10,390 | 7,275 |
| 12 | 1,956 | 9.780 | 17,040 | 12.170 | 8,520 |

NOTE: The levee has an 8-ft. crown and a 3 to 1 slope on both sides.

The type of instructions issued to field men by the Memphis Office was designed primarily to inform the group leader what information was desired, the scale of the map to be made, and the degree of accuracy to be obtained. The methods to be employed were largely left to him. With the general instructions and all other data available, he would make a rather thorough reconnaissance of the stream, set up his camps at the most advantageous places, and give the chiefs of parties definite instructions as to the data to be secured, and indicate the best method for securing them.

The chief of party would then divide his party into groups of about nine men. While one man (of instrumentman caliber) stayed in camp to check notebooks and prepare field maps, the remaining eight were split into two groups consisting of one instrumentman, two rodmen, and a recorder, one group being equipped with a transit or plane table and the other with a level. The chief of party would occasionally operate an instrument but it was found more advantageous not to tie him down to this extent. When the going was particularly rough, axemen were hired locally.

Maps of the U.S. Geological Survey were of great assistance as a guide to reconnaissance for reservoir sites. Surveys of dam sites were frequently exceedingly difficult. The general procedure was to locate the axis or axes of the dam by reconnaissance methods, and then to run a control traverse by transit and stadia with sufficient loops to cover the area. Traverses were tied to land corners or other good reference points. When necessary, the azimuth was established by solar observation. Elevations were determined with the level and topography was filled in by using the plane table. On the resulting map, the axis or axes of the dam were plotted, and profiles of the axes were run, tying to traverses and referencing on the ground, distances being chained and the elevations determined with the level.

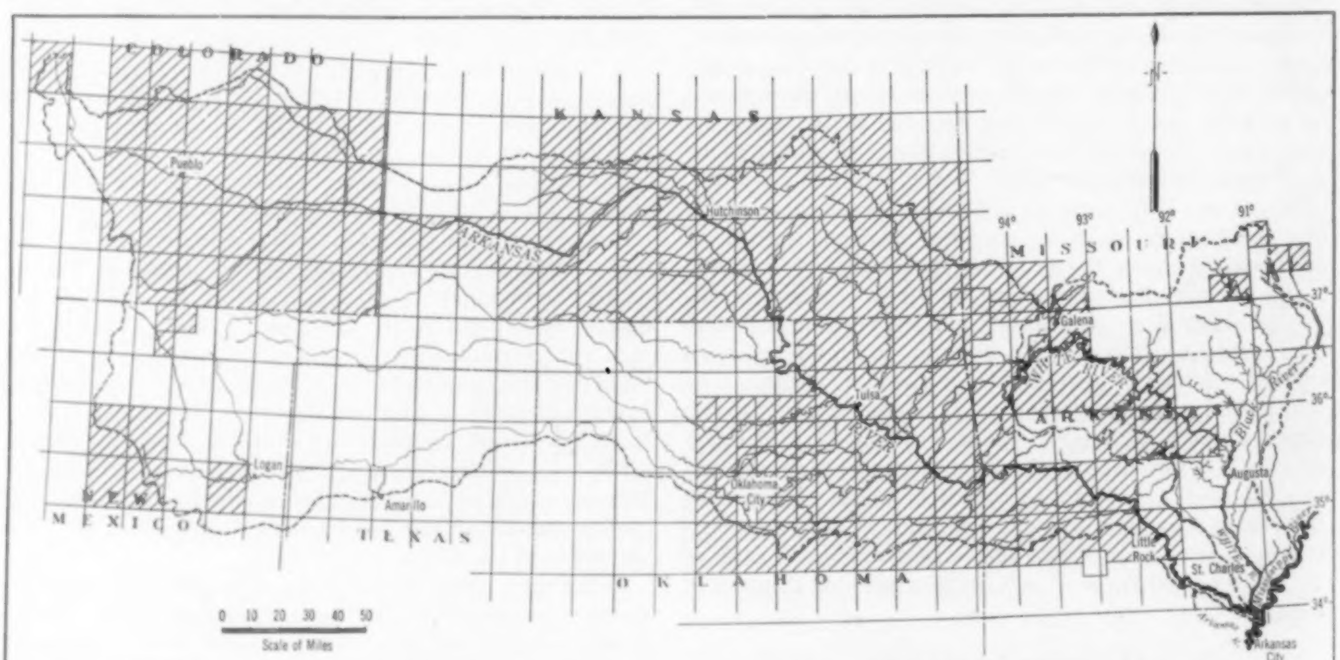


FIG. 1. DRAINAGE BASINS OF WHITE AND ARKANSAS RIVERS
Area Covered by U.S. Geological Survey Quadrangles Shaded

On the main stem of the Arkansas River, from Tulsa, Okla., down, the survey party lived in quarter boats. Three boats, 16 ft. by 36 ft., with a maximum draft of 6 in., were constructed by hired labor at Tulsa; one contained an office and quarters for six men, one was the kitchen and the mess room, and the third, the bunk room. There were 26 men in the party, which was equipped with two trucks, one light passenger car, skiffs, and outboard motors. The latter were used to move the quarter boats downstream.

### SPECIAL SURVEY MADE

A special survey of the Arkansas River Valley, downstream from Tulsa, was made to furnish data for a special purpose map, with a scale of 1:24,000 without contours, to the upper limit of the effect of the Mississippi River backwater. A line of bench levels established the vertical control for this survey. Stadia traverses were run along the bank by the river and fly lines located all old river beds and other essential points of topography.

In general, cross sections of the flood plane of the valley were taken every three miles, where the valley is three miles wide, or narrower, and at greater intervals where it is wider. The cross section included river soundings at close enough intervals to show the channel with reasonable accuracy. The limiting error in bench elevation was taken at 0.05 of the square root of the distance in miles. Stadia lines were tied in on line corners and the limiting error for stadia work was taken at 1:750. Angular measurements in stadia traverses were carried in azimuth with needle readings for a check. Solar observations were taken frequently enough, daily if necessary, to prevent errors in azimuth from accumulating.

The party on this work left Tulsa on December 5, 1929, and arrived at Little Rock, Ark., on September 5, 1930, having covered 352 river miles in this period. The area covered was as follows:

| | |
|---|---|
| Instrumental survey of reservoirs | 900 sq. miles |
| Flood plain and valley sections | 2,525 sq. miles |
| Bench levels | 400 miles |
| Reconnaissance with hand instruments | 4,700 sq. miles |
| Inspection | 40,000 sq. miles |

The total expenditure for this work was approximately $250,000.

On the White River, the same procedure as that described on the Arkansas was pursued and, therefore, it would only be repetition to describe it in detail. A total of 1,700 sq. miles was covered in our survey, with an expenditure of approximately $131,000.

Observations made and lessons learned from these surveys may be summarized as follows:

1. In preparing instructions to chiefs of parties the special purpose of the survey must be kept constantly in mind.

2. Group leaders must be skilled engineers, well versed, through training and experience, in topographic surveying. It is economical in the long run to pay them good salaries. Our office paid these men from $275 to $300 per month, and expenses were allowed whenever camp was not furnished by the Government.

3. A good group leader, by thorough reconnaissance with hand level and compass, can reject or verify as worthy of survey many reservoir sites suggested by various individuals and organizations, some of which appear feasible from the study of a small-scale, general-purpose map.

4. Good instrumentmen are scarce and experienced plane-table men are very rare.

5. It is essential that notebooks be checked in the field and that field sheets be kept up to date.

### A LOGICAL PROCEDURE JUSTIFIED

In preparing general plans for the control of floods and the ultimate development of the water resources of all the major streams of the United States, the Engineer Department is securing the topographic data necessary for the preparation of a general plan that will indicate, for at least a generation, the scheme for the most economical development of the water resources of the streams under investigation. If and when funds are made available for the execution of these plans, detailed plans will be prepared and the construction stage will follow.

# Flood Control Mapping by Aerial Methods

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The general procedure in studying the flood control problems of the Red River in Arkansas and Louisiana, as being carried out by the Vicksburg Engineer District, is similar to the procedure which Major Worsham has outlined for the Arkansas River. In the detailed execution of the work, however, somewhat different methods have been followed. Keeping in mind that the preparation of a general flood control plan does not warrant a large expenditure of funds for the preparation of a detailed map, aerial mapping was decided upon as the best method for economically preparing an adequate map for working out the details of the general plan for the area to be studied.

General reconnaissance showed that there was clearly a flood problem in the Red River valley from the Arkansas-Oklahoma State line to the mouth of the river, a distance of approximately 600 miles. No general maps were available which were sufficiently accurate to be utilized in preparing detailed estimates for a general plan of protection. The preparation of a detailed map by ordinary topographic methods, covering the overflow plain of this river for the 600-mile stretch to be considered, could only be accomplished at a cost in time and funds greater than the present situation in the territory would warrant.

It was, therefore, determined to make an aerial survey

of the entire territory and to prepare a flat map of this survey. In certain critical sections of the valley, control and cross-section elevations were obtained in addition to the flat map. Detailed projects were worked out for these critical sections. These were to serve as a basis for determining the cost of a general project covering the entire area.

AERIAL PHOTOGRAPHS BY CONTRACT

A contract was let for photographing the area to be covered at a scale of 1:18,000. Photographs were obtained by a single-lens camera, with 60 per cent overlap, and there was shown on each a level bubble, a direction-of-flight indicator, and index marks to determine the center of the photograph. The contractor was required to furnish the Government with three prints of each photograph, an index map covering the entire area photographed, and the negatives for the photographs.


A TYPICAL FLIGHT PHOTOGRAPH
Index Marks, Level Bubble, and Superimposed Field Tie Points and Aerial Control

At the same time the aerial photographs were being obtained, a ground-control net was run in loops, each loop being spread across the valley to intersect photographs as nearly as possible at the outside limits of the valley. Loops were run on railroads and highways both because of ease in running the line and because stations on the line would be near points that could be readily identified on the photographs. The control line was run to close with third-order accuracy, and tied to existing control lines run by the U.S. Geological Survey and the U.S. Coast and Geodetic Survey. The final adjustment of the control net was made to the U.S. Coast and Geodetic Survey, North America Datum, and all positions computed for polyconic projections.

As the photographs were received in the office, they were checked for general features, such as clearness, over-lap, tilt, crab, and cloud shadows. A scale check was made in the field at two points in each flight to determine whether or not the photographs came within the variation per-

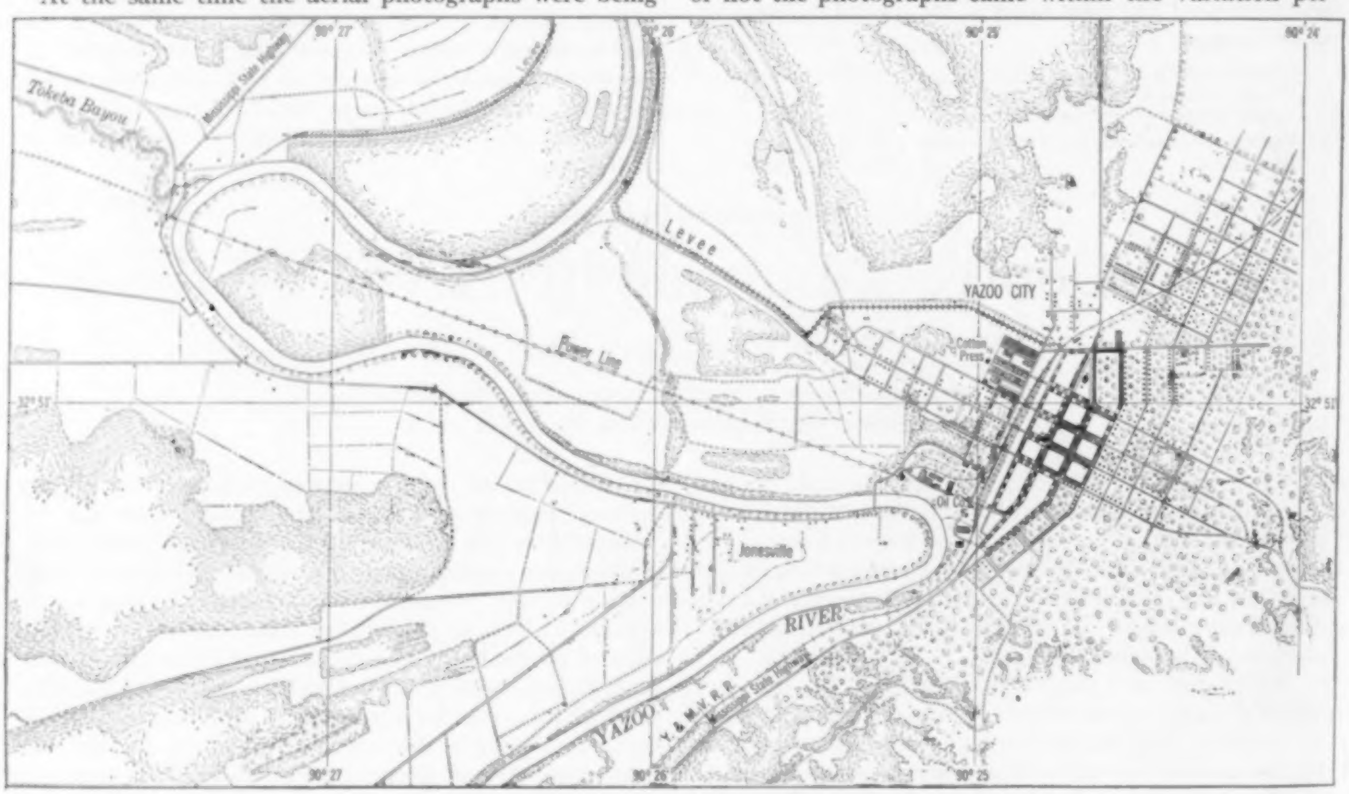


FIG. 1. PORTION OF THE FINISHED FLAT MAP
Scale of Original, 1:10,000

mitted by the government prepared specifications.

Following this, a systematic procedure was followed in tying each flight of photographs (a series of photographs taken consecutively in an approximate straight line) to the established third-control net. Check points were obtained at approximately ten-picture intervals and tied to control stations of the third-order net. Fourth-order stadia lines were used in general for these ties. Tie points, as shown on the typical flight photograph, were indicated on one set of photographs which were taken into the field and later used as the base for the aerial control take-off.

On completion of the survey control work, the flights for pictures, and the tying of the aerial photographs to the control net, the preparation of final maps was begun in the office. Considerable experimenting was necessary to develop the details of some of the methods employed, and various improvements in method were made as the work progressed.

Mapping was carried out on a scale of 1:10,000 and the maps were prepared directly on tracing cloth. The control for maps was built up from the most accurate survey control to the less accurate photograph control and so laid out that no cumulative error could creep into the process. A geodetic projection, using a central meridian for each section of the entire area to be covered, was computed and laid out on the necessary 27 × 40-in. sheets required. Using the U.S. Coast and Geodetic Survey, North American Datum, as a base, the third-order survey control net was computed in geodetic position and plotted on the geodetic grid laid out on the sheets, as shown in Fig. 3. The fourth-order photographic ties between the third-order system and the photographs were next plotted in geodetic position on the same sheets.

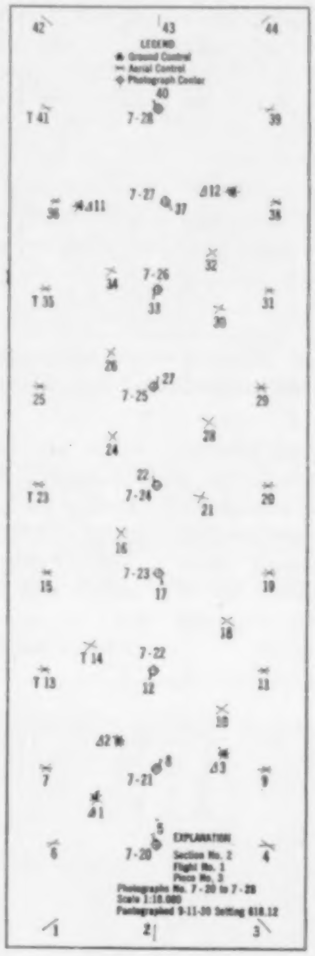


Fig. 2. A Sample Aerial Take-Off Sheet

Further auxiliary, or "aerial," control was obtained by projecting a radial line "take-off," as shown on Fig. 3, through each flight of photographs. This system in general was so laid out that at no point would there be a distance greater than 2 in. between control points on the final tracing. This aerial control was prepared from flights of photographs and matched to adjacent flights, by identification of points included in side overlap.

According to this method, a network of points is selected and marked on each picture. All such points as shown on the next picture are also marked and additional points in the forward direction of flight selected. Repeating this process, a complete network of points is obtained throughout the flight.

Next, using the index marks on the sides of the photographs, the center of each photograph is determined. This is followed by the construction of radial lines to each of the aerial-control points marked on the pictures. As there is a 60 per cent overlap in the direction of flight, there are several points which will appear on each of three pictures and can be used for matching them.

### Orientation by Radial Line Method

A tracing-paper, take-off sheet is laid out to cover each flight. The center of the first photograph is located and radial lines drawn through each of the aerial-control points, orienting the picture on the line between the center of Photograph 1 and Photograph 2. Photograph 2 is then taken, oriented on the line between centers of Photograph 2 and Photograph 1 and moved forward or back along this line to give the best adjusted match between location of aerial-control points. The third picture is handled in the same manner, and so on through the flight.

The first two pictures give an intersection of radial lines and the third picture gives a check intersection, the true position of the point being taken as the center of the triangle of error. The azimuth of flights and orientation of each picture are determined by the line through picture centers. Usually the actual center is a point difficult to identify and a point near the center is used to match overlapping pictures, although the orientation is accomplished by the actual line between centers. Thus a network of aerial control at the scale of the photographs is obtained.

At the beginning and end of each flight, certain of the aerial-control points were tied in to the third-order control. Distances between these tie points is known and, by scaling the distance as actually determined on the take-off sheet and comparing with that actually measured in the field, the scale of each take-off sheet can be determined.

### Pantograph Enlargement of Control Lines to Map Scale

The next operation was to enlarge by pantograph from the scale of the take-off sheet to the 1:10,000 scale of the final map. As only control points were so enlarged, this is a comparatively simple operation and can be completed very rapidly.

Adjustment between control points on a flight and matching to overlapping flights is accomplished at this time. This is done by taking off the enlarged aerial grid by the pantograph on a detail sheet, and placing the tracings with survey control already plotted on them over the aerial grid to match at both ends and to make a proportional adjustment between ends. Errors in position of side points are adjusted by plotting the true position on the tracing as the average of the two apparent positions obtained by side-overlapping flights. The adjustments necessary between controls and for side overlap indicate an accuracy of the aerial take-off about equivalent to stadia surveying. This operation completed, the points are transferred to the tracing for the map, which is then completed, as far as control is concerned.

Each map sheet has thus plotted on it the basic polyconic grid, third-order control, fourth-order control, and aerial control, and has been so built up that errors in fourth-order and aerial control are not cumulative, but localized between check points (Fig. 3).

### TOPOGRAPHY TRACED FROM PICTURES

To place detailed topography on this sheet, a photographic enlargement of each photograph is obtained. On this enlargement are indicated the aerial-control points previously transferred to the control sheet. Then, by using a light table and placing the tracing cloth over the enlarged photograph, on a scale of 1:10,000, the finished map may be traced by adjusting each control point over the corresponding point shown on the enlarged photograph. Small variations in scale of the photographic enlargement are of no consequence, as only topographic features adjacent to each control point are traced from that point.

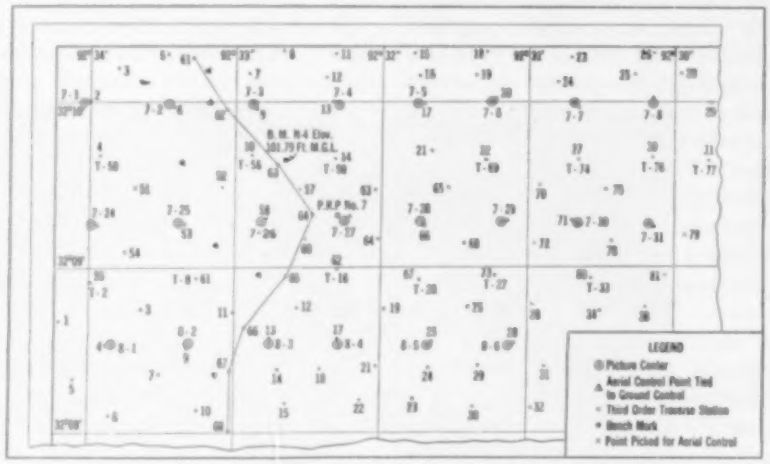


FIG. 3. PORTION OF A CONTROL SHEET
Geodetic Grid, Third- and Fourth-Order Survey Control, and Aerial Control

By these methods a very complete flat map of the area to be studied has been prepared. Where elevations are desired, additional field work was performed to obtain the necessary cross sections, but for portions of the flood control studies, the flat map alone is sufficient. Fig. 1 shows a sample map prepared.

In the Red River Valley, a total of approximately 2,500 sq. miles has been photographed, and the mapping of approximately 1,500 sq. miles has been completed by the methods described. Similar maps are being prepared for the backwater areas at the mouth of the Yazoo and Red Rivers in order that studies for flood protection may be made. Approximately 19,000 sq. miles of photographs are being obtained.

Many other uses of photographs in mapping have been found, and it is believed that aerial photography will play an increasingly important part in the preparation of maps for flood control work.

## Modern Water Works Engineering Malay Peninsula

*Singapore Water Works*

SULTAN IBRAHIM DAM

FILTER PLANT

Showing Conduit from Reservoir

Photos by Harold E. Babbitt M. AM. SOC. C.E.

# Problems of a Large City

OPENING SESSION OF THE SOCIETY'S ST. LOUIS MEETING
CONSIDERS THE FUTURE OF THE AMERICAN CITY

*IT IS becoming clearer each day that the story of the town is about at the end of a chapter. The city of the late eighties was not greatly different in structure from ancient Rome or Pompeii, but the city of tomorrow may easily be like nothing that ever was.*

*We have had to invent a new agency which we call city planning and have complacently assigned these matters to it. Today it appears to be crying for help, handicapped by having to keep one hand on the holes in the bursting wall of the old city while the other attempts to shape the outer terrain. It is evident that city planning, joined with organized business, has had to devote its efforts primarily to retarding the too rapid change, if not dissolution, of the older city but it may be able to do no more than avoid cataclysmic revision. It will be especially interesting to see whether the rural district, which has been giving up its people so freely to the city, is about to receive them back with bits of the city sticking to them.*

*The Program Committee has permitted a group of St. Louis people to present matters pertinent to this theme. They can do no more than set up cases. It will be the task of the profession at large, through discussion, to develop tentative conclusions.*

*From the introductory remarks of Chairman W. W. Horner, before the Technical Meeting of the Society, October 1, 1930. The following are abstracts of the papers delivered at that time.*

# Why the City

*By* DR. W. F. GEPHART
VICE-PRESIDENT, FIRST NATIONAL BANK IN ST. LOUIS

A CITY is an aggregation of human beings living in a restricted area under a single political control. Its origin is to be found basically in the fact that man is a social animal, although primitive man lived in groups partly as a protection from other tribes and from animals. In fact, it has been chiefly in the Western Hemisphere that large numbers of people have lived in comparative isolation, since in both Europe and Asia even those engaged in agricultural pursuits have always lived in communities. The fact that pioneer conditions in the New World tended to scatter the population on farms as individual family units, has accustomed us to make a distinction between urban and rural population.

Throughout all time, apart from man's social instincts, the basic reason for the existence of the city has been economic, although other factors have also played an important part. Centers of political and religious control and towns located where natural highways intersected tended to grow more rapidly than others. Location has been especially important where waterways meet or where a waterway is crossed by a natural highway route.

### ECONOMIC FACTORS AFFECTING GROWTH

The chief economic factors responsible for the location and growth of modern cities are: (1) the natural resources of the hinterland and surrounding area; (2) transportation facilities, in the earlier period, especially those supplied by nature; (3) topography of the surrounding area; (4) conveniences which are possible in a restricted area; and (5) the impetus of an early settlement. Certain minor factors such as labor supply, distributing facilities, educational and religious agencies, and climate also affect, in a smaller way, urban growth.

No great center of population can exist without having near at hand such raw products as foods, minerals, materials for clothing, and forests, which supply the elementary wants of man. Yet, under our highly complex industrial and financial organization, a considerable part of these products need not, now, come from the immediate vicinity. London is an example of a city which draws its raw materials from, and sends its products to all parts of the world. Like others of the world's largest cities, it is an international warehouse and its hinterland is the world. Nevertheless, the establishment and early growth of any city are primarily dependent upon the natural resources of its surrounding area.

Since the city is the center of manufacturing and commerce, facilities for transportation are of great importance. Before the development of the railway and the improved highway, natural waterways were often the determining factors in the location and growth of cities. And today in the United States internal waterways are increasing in importance, both because they afford an economical method of transporting bulky products and because of the growing congestion in railway terminals.

### CONVENIENCE PLAYS IMPORTANT ROLE

Another reason for the establishment of cities, as well as a factor in their growth, is that of convenience. Collectively, people can have water mains, gas systems, electric lights, educational institutions, theaters, parks, and libraries which they could not enjoy otherwise. While these may be under the control, and, as we are accustomed to think, owned by certain individuals, it is the collective living of the people that makes them possible. It is of interest to discuss some of these factors as they have affected the location and growth of some selected cities of the United States.

In the case of St. Louis, their influence is clearly evident. It is located in the center of the Mississippi Valley, one of the largest single areas in the world so liberally endowed with natural resources; it is near the geographic center of the United States, and what is more important, near its population center. For transportation, there are three great river systems, and a highly developed railway and highway system. Given the great Mississippi River system, there was bound to be a city somewhere along that river, between the mouths of the Missouri and Ohio Rivers. Other factors, such as an early start and topographical features, have also played their part.

Chicago, also, is surrounded by an area rich in natural resources, while much of the traffic of the North and Northwest must pass around Lake Michigan and through Chicago's industrial district on its way to market. Cheap transportation facilities give it an enormous advantage, and it is undoubtedly destined to be a much larger city than it now is.

New Orleans, at the mouth of the Mississippi, is a natural gateway, and also has had the advantages of natural resources and an early start.

As for New York, the largest city in the United States, it has an excellent harbor, an extensive waterfront, and, especially in its early days, its location at the mouth of the Hudson River was of great importance. Its hinterland was then much of the territory east of the Mississippi Valley, and it was able to achieve an early leadership, which has been a continuous factor in its growth.

Pittsburgh, at the junction of the Allegheny, Monongahela, and Ohio Rivers, in a section rich in minerals and forest products, early became a distribution center for settlers and goods consumed by them. With the canalization of these rivers, the Ohio has again become an important factor in its growth.

Akron, Ohio, is to a certain degree an example of a city which owes a large part of its growth to having early become the center of an industry—rubber, which brought with it related industries. This industry might have developed in any one of a half dozen other cities.

In the case of Detroit, natural wealth was later succeeded by the automobile industry as the most important factor in its growth.

### EARLY PREPONDERANCE OF RURAL POPULATION

One of the most striking developments in the United States in recent decades has been the growth in urban population, although this simply means that population here is becoming what primarily it always has been—urban. At the time of the first census in 1790, there were only six cities in the United States with a population of 8,000 or over, and as late as 1880, two-thirds of our population was rural. Two causes are responsible for this great change; first, the millions of immigrants who came after the Civil War as employees in mills and factories; and second, the greater economic opportunities in the city and the application of machinery to agriculture. The city attracted the rural population not needed on the farms, which were already producing a surplus of food commodities.

By 1920, the strictly urban population exceeded the rural, and although final figures for 1930 are not available, the best estimates indicate that 57 per cent of our total population are now urban. And this does not mean that the remaining 43 per cent are rural in the sense that they live on farms. Dr. Galpin, of the Bureau of Agriculture, estimates that only about 27 million people, or about one-fifth of our population, actually live on farms. Otherwise expressed, from 75 to 80 per cent of our people are now making their living from commerce and industry rather than from agriculture.

### URBAN PROBLEMS TO BE SOLVED

It thus appears that the United States is rapidly becoming a nation of city dwellers, which brings to the fore the problem of the modern city, especially in the United States. The modern city is, among other things, unnecessarily congested; it is often badly governed; it is unnecessarily dirty; it is unnecessarily noisy; and, with few exceptions, it is ugly.

Congestion might be avoided by locating numerous office buildings, railway offices, and the small as well as much of the heavier manufacturing in the outlying areas. The railway-rate structure is in part responsible for this congestion. It developed following the Civil War, and has at present little to justify it except precedent. Basing the rate to points nearer or beyond a great industrial center upon the rate to the center, and the rate to the center on potential water competition which no longer exists, has done much to concentrate industry and population in restricted areas. If, for example, due consideration were given to the enormous capital investment in terminals, the city manufacturer or distributor might well, if he paid his share of the rate, pay much more than he pays now.

Rural population has a higher birth rate and a lower death rate than urban. Our cities have grown so rapidly that little attention has been given to keeping them clean and in good sanitary condition; dirt and smoke characterize many of them. It is only recently that the problem of city planning has been taken up seriously in an effort to correct over-crowding and the absence of air and light which is found even in the better residential districts.

Ancient and medieval cities were both unsanitary and congested, but none of them approximated the average American city in the variety and volume of noise. The nerves of the city dweller are continually assaulted during all his waking hours by a great variety of unnecessary noises, and even while he is asleep he is not free from attacks. Due to good roads and the automobile, there is beginning in this country a movement in the larger cities for the people to move out into the country, where there is more air, more light, more sunshine, and numerous other advantages from the standpoint of living. The newer cities present a much better appearance than the older city that grew in a haphazard manner.

### INEFFICIENCY IN CITY GOVERNMENT

While the American people take just pride in having devised and developed a form of federal government suitable to their character and genius, they have not made a striking success of city government. The chief functions of the government of an American city are of a business and not of a political nature. No large business organization imagines it can secure efficiency

unless it concentrates authority and responsibility, and yet in our cities we frequently have two legislative bodies, numerous boards or commissions, with authority so distributed that great waste results in the expenditure of the city's enormous revenues. Little can be accomplished until municipal government is simplified, and the citizens realize that its chief function is not political.

On the one hand, the American city is a concrete expression of the amazing energy and genius of the American people, and, on the other, a social monstrosity which is gradually being modified into a more beautiful, more sanitary, and more quiet habitation for man.

# Municipal Preparedness

*By* E. R. Kinsey
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MUNICIPAL preparedness suggests the problem of plans needed for the progressive development of a municipality. If development is to be really progressive, without lost motion or waste, these plans should fit into and be integral parts of a comprehensive city plan, which in turn should be a unit in a comprehensive regional plan. Makers of such plans must remember that cities are not sufficient unto themselves. They draw their sustenance from their trade territory, which is to be served rather than exploited.

Each city has a destiny which sometimes is not as manifest as its booster organizations take for granted. Unprejudiced study should be undertaken to determine, as far as is possible, just what part the city is to take in the Nation's growth. Starting with such an intelligent vision of its probable future, the city must prepare for it by careful planning; any other procedure will result in enormous waste, both of capital and of opportunity.

### Cities Cause Waste

Cities must assume responsibility for inefficient handling of that portion of the Nation's business transacted within their confines. The difference between the price the producer gets for a given article and the price the consumer pays for it is so great that the average man is sure too many and too large profits are claimed by middlemen. Doubtless the spread between these prices is excessive, and doubtless a part of this spread is waste, much of which occurs in cities. Long distance transportation of goods is now effected more economically than ever before, but the cost of getting them to their final destination within the city is entirely out of proportion to the long-haul cost.

Contributing to this waste are such items as inefficient harbor development; lack of modern river docks; inefficient street systems leading to docks, team tracks, and terminal facilities; improper location of those businesses requiring transportation with reference to transportation facilities; and improper correlation of business within the city, which, with poor street layouts, necessitates much avoidable and costly trucking. These defects are to be found in all large cities; those that correct them will be amply rewarded for their foresight.

The city planner's attention will probably be directed first to problems of transportation—to facilities for the movement of goods by rail, water, air, or along streets and highways; and to facilities for mass transportation of people and for the movement of private conveyances. Directly related is the zoning plan, by which industry and business will be located where they may best be served by all the transportation facilities.

### Cost of Inaccessibility

It is a common experience to find in American cities sections which once were valuable, but which have deteriorated because the avenues of approach became congested. Land without accessibility is valueless. The maximum value of any land used for a specific purpose is attained only when all the accessibility required for that purpose is provided. Enormous waste in land values occurs in those localities where existing transportation facilities have become inadequate.

Promoters of new industries seeking locations in cities have many questions to which they must have an answer. Assume an industry which is expected to grow to much larger proportions and for which a location is sought in partially undeveloped territory. What assurance is there that adjacent land will be available for expansion or for use by related industries; that streets necessary for full access will be provided; that major thoroughfares will be put through to connect the location with other industrial and business localities; or that there will be suitable residential facilities for employees within a reasonable distance? An established plan, officially adopted, gives assurance to the investor and protects the investment.

### Conservation of Man Power

There remains the greatest factor in the city, its man power. Leaving out of consideration humanitarian concepts, it still will be good engineering to promote and conserve the health, comfort, convenience, happiness, and morale of the people. The well planned city is prepared to expand such facilities as pure water, good sanitation, enough light and air, and recreational projects as its growth may require.

It is neither good business nor good engineering to plan

an ugly city, however well the utilitarian requirements may have been met. An ugly public square is a reflection on the good taste of the entire community. Promoters of real estate developments spend money in making their lands attractive primarily for the purpose of making more money. There is very real and very great value in attractive vistas, impressive grouping of public buildings, and in the embellishment of public places. Americans are becoming a cultured people, and the city plan should be an expression of the best culture of the community.

### MASS TRANSPORTATION STILL NEGLECTED

Many obvious community problems have already been solved. Cities have provided themselves with pure water and adequate sanitary facilities. Other problems are now becoming more obvious, among them the need for mass transportation. Suppose the cost of renting the needed capital, plus the cost of materials, plus the cost of labor and personnel needed for operation and management, exceeds the sum realized from the collection of the fares which riders are willing or able to pay? The answer is that the community needs the service and should meet its cost. It adds to community values and it should be paid for in full, but should not be exploited for unreasonable gain. The time is coming when some cities must be prepared to provide this service even though the entire cost cannot be met through the collection of fares.

The community must take and the private owner must yield, for just compensation, all the land needed for community purposes. There is no reason why the community should, by its acts, confer great special benefits on private property without exacting a fair return.

### PREPARING FOR EXPANSION

Communities must reach out beyond their present confines and hold for future use such areas as will surely be required for recreational and other purposes, before other occupancy makes their cost prohibitive. Large tracts used for country clubs and golf courses exist close to many cities and are often the last remaining tracts suitable for future parks. A form of acquisition should be devised whereby these tracts may continue in their present use until required for public use as parks. Legal opinion is in a state of evolution, and the broadening exercise of general police powers is found by the courts to be constitutional.

Cities do not think; if the people in them do not think understandingly of community problems no progress can be made. I was asked to discuss "Municipal Preparedness"; I am inclined to define it as a state of the public mind. A foundation of popular understanding of the problem must first be laid, backed by a feeling of responsibility that will prompt the expenditure of public funds for the community's benefit.

In many American cities there is a splendid growth of the individual's sense of obligation to the community. Cities have a like obligation to their environments, and a recognition of this responsibility should be stimulated.

### ENGINEERS ARE NEEDED

Leadership in the group of those civically minded is naturally taken by those most able and most unselfish. Among these are the good citizens who are satisfied with a reward based on their individual contribution to society rather than on their ability to grab wealth at the expense of others. No group of citizens fills this specification better than do engineers, and few groups are more diffident than engineers in asserting themselves on public affairs.

By training and practice, the engineer is fitted for straight thinking and sound judgment. As a citizen, he has a duty to his community and his help is much needed, and, needless to say, should be adequately remunerated. If cities are to grow properly, it will be only when engineering habits of thought leaven the public mind and stimulate logical and sane planning for the welfare of the whole community.

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# Supervised Regional Expansion

*By* A. P. GREENSFELDER

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CHAIRMAN, UNIVERSITY CITY PLAN COMMISSION, ST. LOUIS, MO.

SIZE, in America, is no longer the only criterion of a city's growth. Quality is rapidly overcoming quantity in the determination of relative city merit. Metropolitan grouping is spreading—"conurbation" they term it in England, where one huge urban area is surrounded by satellites more or less dependent upon it, and which have grown on account of such proximity.

Thomas Adams, noted county planner, has stated that, comparatively, a city of perhaps 50,000 people may hold the most contented citizens. Such a city is large enough to support all the public conveniences, and yet not so large as to compel inconveniences. Crowded and long-distance rapid transit facilities are unnecessary there. Taxation can be moderate. Urban "rationalization" or maximum elimination of waste may be possible in medium sized towns rather than large ones.

A city that is backward can go forward properly only when it budgets and plans its future as does an individual corporation. On the other hand, as engineers, we are apt to think of maps and engineering too literally. Engineering is a means to an end. The end itself is increased happiness to the citizens of a community.

While the planning of a small city is a relatively simple task as compared to a metropolis or a whole region, nevertheless the human factors are very much the same. Few citizens really know the full intent and objectives of community planning. It is, therefore, essential that individually and collectively they be "sold" on the subject.

The Plan Commission of University City has invariably endeavored to "sell" the idea of planning rather than merely to compel compliance. Cooperation is more valuable than compulsion. True enforcement comes only with complete recognition of greater personal benefit, rather than least loss, by compliance. Court delays sometimes permit the lapse of time essential to educate both officials and the public.

Fourth and Olive Streets, St. Louis, in 1850

Be a plan ever so perfect, it is useless unless adopted by the affected political subdivisions of the State. Politicians necessarily keep their ears to the ground Prudent planners will see that the "ground swell" is loud and insistent. A plan is not of necessity imperfect because it is popular. The courts and popular opinion have ruled that justice shall be done. Therefore, it is proper that the execution of a plan should provide for boards of adjustment. They provide a practical means of easing personal pain.

If planners would hold more meetings and hearings before preparation of a plan, rather than afterwards, they would very probably progress faster and further than they do now, and might meet with less opposition and discouragement.

### COORDINATING CITY AND REGIONAL PLANNING

Realizing that the isolation of any city in a region is just as illogical as isolating an individual in a city plan, we have always coordinated with kindred spirits, local engineers, and planners in a campaign of education to establish a regional plan in the St. Louis District.

University City is indebted to Harland Bartholomew and Associates, nationally known planning engineers of St. Louis, not only for evolving our own city plan, but also for coordinating it with the plans of Greater St. Louis and the immediate adjoining or neighboring communities.

The situation in the St. Louis District is not essentially different from that in the regional districts of other cities in the United States. A number of cities have already made great progress in the development of their respective regional studies, such as New York, Chicago, Philadelphia, and Cleveland, and we hope to benefit by their experiences. As yet, there are comparatively few regional plan commissions in the United States as compared to 750 city plan commissions.

Whenever a region includes portions of two or more States, as well as several counties and numerous towns, cooperation is more or less cumbersome and difficult. This is due to the presence of numerous political boundaries and their respective politicians. Naturally, each political group is more or less self-centered and jealous of its legal prerogatives. Citizens are taught to take pride in their respective communities, regardless of their lack of active civic interest. While this "boosting" attitude may be good, it is frequently overdone and occasionally leads to imperfect perspectives of the relative merit of a community as compared to similar areas elsewhere.

### HISTORICAL AND TRADITIONAL INFLUENCES

People are traditional. Their history lessons have accentuated their local traditions without explaining the economic origin of their city. The influence of climate, soil, and markets should be investigated and explained to the various commercial and civic organizations of the community. Frequently these old traditional influences can be modernized.

We are too apt today to make our "Main Street" the same as the Main Street of every other American city. This idea of copying without localizing is an unfortunate American tendency. Every plan should be individualistic and should endeavor to specialize with regard to local history and environment for architectural and engineering development.

One of our first studies might well be along commercial lines. This can draw support from commercial institutions and various crafts of industry, particularly since the preliminary financing of a regional plan is usually on a voluntary subscription basis.

### COUNTY COMMERCE COORDINATED

All sources of income to a community should be obtained by questionnaires and the material studied and classified. They may be agricultural, mineral, industrial, commercial, or recreational, in varying degrees. The growth of the wealth of a community should be traced by land values and improvements and the trend of taxes should be clearly and simply portrayed. The financial growth of transportation and other public facilities should be presented. The necessity for intercounty relations, as seen in connecting highways or "regionways," bridges, public health, horticultural disease, policing, and marketing should be traced.

Natural resources of a community, such as scenery, soil, and water, should also be considered. A study of aesthetic geography may develop as much income-producing property as a geological survey. Finally, the financial benefits of planning and zoning, such as mini-

mizing bond issues, increasing income, and producing better living conditions, should be stressed.

### TAXATION, BOND ISSUES, AND ASSESSMENT

The taxation problem of the community should be examined and portrayed in the early stages of a regional plan. Too frequently this matter, seemingly so personal and vital to the taxpayer, and unduly stressed by him rather than the benefits receivable, is delayed until the full completion of the future engineering work.

A flow sheet indicating the income and expenditures of taxes should be plotted. There is always more or less public objection to the superimposition of several jurisdictions upon various areas, such as park, sewer, and drainage districts. It multiplies taxation. Bond issues for general improvements might be extended from 20 to 50 years, varying with the "useful life" of the project, thus diminishing the annual sinking fund. Whether direct or indirect, one is no more taxation without representation than the other. On the other hand, provision might be made for the more equitable division of costs of through streets and stormwater sewers as compared with the present method of all-local, special tax bills for their improvement, reconstruction, or maintenance.


FOURTH STREET AT OLIVE LOOKING NORTH, IN 1930

School taxes for educational institutions, from the lowest to the highest, should be carefully scanned and compared with similar districts elsewhere. Systems of property assessment, comparison of assessed values as made by State boards, and the "visible" types of property to be assessed should be studied. Excess condemnation should be legalized.

How planning can minimize taxation should be told and retold upon every occasion. Prevention of duplication of water supply, electric power, and district sewer facilities is an essential purpose of a plan, while cooperative functioning can minimize expense of institutional and public facilities.

### INDUSTRIAL DEVELOPMENT

A study of the development of a community is frequently considered solely the business of the commercial organizations of that community. Yet, the viewpoint of a commercial analyst and a regional planner may be totally different. The chamber of commerce is usually bent on immediately increasing the volume of commercial transactions, the number of new industries, or the population of its community. The planner surveys, however, both the present and future regional requirements. Both parties are interested in conserving the present industrial plants by fostering their physical growth; a joint survey might be mutually advantageous.

Such a survey might include raw materials, their volume, origin, and delivery; land areas and transportation facilities of all kinds; building, with special reference to climate, lighting, standardization, and asset value; demand and supply of fuel and power; and national and foreign markets for local products. The availability of labor, its skill, turn-over, and contentment should also be investigated. Transportation rates should be analyzed.

It may be that good roads, cheap automobiles, and elimination of the need of feeding farm horses and hens may make movement of the farmer's family to the village a very desirable thing. The men can motor out to the farm daily, thus permitting the women to have some much needed social life, the children better schooling, and the whole family more religious contact, and "movies," or other entertainment. Thus, the present drift from country to city and from city to suburbs may be balanced. Community dairies, laundries, and bakeries are as socially sound for the small village as for the large city.

On the other hand, the present practice may be rationalized in our great metropolitan centers of permitting private interests to build huge "skyscrapers," and then force the public to expend high taxes to provide rapid transit, double-deck streets, and other expensive facilities, due to the consequent concentration of people a few hours a day. New York City has a subway system which will cost one and three-quarter billion dollars. A tremendous tax burden per capita, and no end in sight! Even "set back" buildings lose their many attractive features when built too closely together.

Centralization as well as decentralization of population has its advocates and each has its own blessings and penalties. Each person will ultimately decide for himself in the light of his own knowledge, desires, or experiences.

### CONNECTING HIGHWAYS

Proper researches of the above so-called intangible subjects are likely to produce rather remarkable results. The national traffic-congestion bill is estimated at two billion dollars per annum. A blockade or a detour costs time and money. Traffic studies are, therefore, one of the first arithmetical necessities. Their tabulation,

analysis, and graphic presentation can usually serve as an efficient guide for highway development.

Unit motor operating costs determine the efficiency of grade crossings, super-highways, and direct connections. Securing adequate rights-of-way, and the determination of building lines must justify themselves. A study of property-value stabilization and trends is vital. Legal authority should be obtained to prevent building within streets mapped on the plans.

"Low-ways" usually permit the ready elimination of grade crossings on arterial highways crossing the valleys, and frequently the meandering valley routes provide opportunity to make beautiful parkways for passenger vehicles.

### CAREFUL PLANNING PAYS

By coordinating comprehensive highway plans, covering each county and city in the region, the major highways can be properly connected to ensure continuity with uniform widths. Such plans will serve to guide simultaneous construction of main arteries by the various public authorities and thus hasten the opening of through regionways. They will also permit the logical allocation of paving funds from year to year. With hard pavement costing $40,000 a mile, the saving of half a mile by careful planning will more than pay for a whole county plan.

Boulevards, derived from the word meaning bulwark in Europe, is usually considered too fanciful a term to discuss with farmers. The word "highway" is purely a statement that it is a public rather than a private way. Therefore, the term "regionway" is suggested as descriptive of its purpose, to supply access from one part of the region to another.

The planning or highway engineer is too apt to insist upon straight lines with moderate grades for all kinds of highways. We are apt to overlook scenic opportunities and fail to provide convenient look-outs and resting places for the weary toiler or traveling tourists. Thorough topographical surveys should be made available. A Columbia River Highway is not only a national scenic wonder, but a local engineering achievement that pays daily dividends in tourist travel.

### BILLBOARDS AND TREE PLANTING

The importance of tree planting and beautification of the countryside are becoming more thoroughly recognized not only by our State highway departments, but by our local authorities. In England, there is an Association for the Preservation of Rural England, which would serve as an excellent guide for American practice. If we would tax billboards on a square foot basis, it might eliminate many small ones along the highways, and probably remove many square miles of useless and unsightly obstructions. A number of nationally known advertisers are beginning to recognize the resentment of the American public to this despoilation of the landscape.

The use of signs by T. H. Cutler, Missouri State Highway Engineer, along the major highways surrounding St. Louis, calling to the attention of property owners that the highway is to be ultimately widened to definite widths, is to be commended and will save condemnation of buildings later. Milwaukee County, Wisconsin, has gone even further in this direction by officially adopting a major highway plan and posting notices along the roads of the respective width of final ways.

The adoption of an official highway plan accentuates and speeds the obtaining of rights-of-way. Cook County, Illinois, has obtained the dedication of hundreds of miles of right-of-way without cost to the county by the publication of its official plans and education of the public. The average American will dedicate if he is assured his neighbor will do likewise.

The problem of toll bridges between counties also needs clarification. It is often miles and time vs. tariffs. The bridge permit should require, however, that in a moderate number of years the bridge should become a free public structure.

Lighting of highways and requirement for freight transport at night instead of interference with day passenger traffic may, in certain cases, be more economical than widening hard pavements.

### TRANSPORTATION

Highways are only one of the four ways now open to transportation. The coordination of highways with railways, waterways, and airways is essential. With the introduction of the Diesel engine, steel-hull barges with open covers, adequate terminal and transfer facilities and with sufficient traffic, the waterways need new consideration from the planning standpoint.

Railways, through modernization, consolidation, and coordination of terminal facilities, are providing more rapid, convenient, and efficient service than ever before in their history.

The electrification of terminals and main lines to provide more efficient operation and to diminish smoke nuisance, is rapidly spreading. The elimination of rail and highway grade crossings is an important problem in regional planning. In America today, vast sums are being spent for the elimination of grade crossings, and yet more new grade crossings are being opened each year than are being eliminated.

Belt lines, rapid transit, express bus transport, interurban lines, adequate street railways, and equitable zone fares all have immediate and direct bearing on neighborhood growth.

Airports are one of the most modern essentials for rapid transit. Locations convenient to the heart of population are desirable, with speedways between. Owing to the noise of the airplanes, however, the location of airports near residential neighborhoods or districts is today deemed undesirable.

### LAND SUBDIVISIONS

Closely allied to the highway portion of a plan is the matter of land subdivision, which has almost become an exact science. The larger the area to be subdivided, the more apt is the public to obtain its full share of facilities. The subdivider of a city block can afford to offer relatively little to community needs. On the other hand, large tracts lend themselves to economical development of highways by curving streets and to the use of areas which cost much to excavate as recreational spaces, which, in turn, increase the value of surrounding lots.

Regional plans should differentiate between urban, suburban, and rural areas. The latest thought indicates that "green girdles" of open public lands should separate

these zones. Where zoning has not been applied, subdividers can protect their outlying boundaries by agreeing with owners of the surrounding acreage upon "neighborhood restrictions."

Care should be taken to see that easements for poles, sewers, and other public facilities are provided in the rear of lots in order to keep the residential streets free from disfigurement. These public easements should not be less than 5 ft. wide, and preferably $7^1/_2$ to 10 ft. in the rear of each lot, in case it may be desirable to provide for future alleys or minor thoroughfares.

###### RECREATIONAL FACILITIES

Recreation has until recently been considered a pastime, and, for the most part, only for children; its value to adults has been more or less only recently recognized. There is a distinct relationship between misdemeanors and lack of playground facilities. Park attendants are cheaper than policemen. The construction of apartments decreases the private back and front yard per capita and increases the demand for public open areas.

The need of proper coordination of the school and playground is becoming well recognized and considered essential. To minimize the taxation for the two facilities, the new schools of University City provide, in their segregated basements, plenty of benches, tables, and other facilities for the children using the playground after school hours. The School Board provides the janitor, while the Park Board provides the playground director and the outdoor equipment.

The provisions for water facilities are essential, both interstate and intrastate. We introduced an enabling act in the recent Missouri legislature providing for the establishment of river-valley conservancy districts, which would enable the complete conservation of each major intrastate river by permitting the creation of a district covering that watershed area. It will provide for water-power development, flood control, navigation, potable water supply, fishing, boating, and swimming, all through proper allocation and regulation. Several States have river legislation covering one or more of these facilities, but as yet no State has a complete river-valley conservation plan.

###### PLANNING FOR HUMAN HAPPINESS

The engineer's application of the general sciences to planning has been more or less remote. We are apt to forget that scientific achievement alters community needs, and that science therefore has a direct reaction upon city planning.

Calmness that engenders thought may be more creative than speed which exhausts and confuses. Planning should be planned. Realization of the plan is the ultimate goal. Planning the minds of children may be more reasonable than pouring miles of concrete. Making men other than automatic robots may be more desirable than merely duplicating facilities of transport. Our final measure of successful community planning must properly be: how much and how fast can we really increase human comfort, happiness, and hope?

# Developing the City's Water Supply

*By* EDWARD E. WALL
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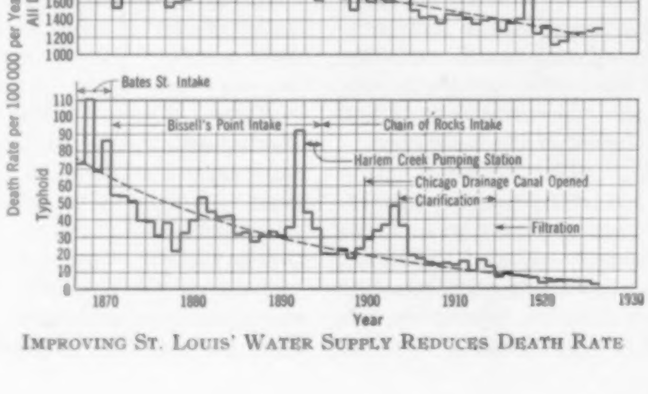
OF ALL the problems confronting our large municipalities not one is more important to their growth than procuring and maintaining an adequate, safe, and potable water supply. That which, 40 years ago, was the comparatively simple task of conveying the nearest available supply to the consumer, has been developed into a highly technical science, involving branches of engineering then undreamed of, and reaching out into many fields of practical and theoretical research.

It is but little more than a generation ago that public sentiment began to be aroused to an interest in the purity of the water distributed to the larger cities; before that time its taste and appearance were matters of far more moment. It was believed that rivers purified themselves of all pollution in flowing a few miles from the source of contamination, and that the immense body of water in lakes, with its currents flowing in many directions, would accomplish the same result.

Where the source of supply had become so seriously contaminated as to give an unpleasant taste or odor to the water, it was the general opinion of engineers that it was better to seek a new supply, even if it was necessary to go far away at a considerably increased cost. Just before the end of the nineteenth century, the prejudice against the use of chemicals in water purification was so strong that many engineers advocated national legislation for the prevention of the pollution of natural waters of the whole country, in order that these surface waters might be safely used for domestic consumption.



IMPROVING ST. LOUIS' WATER SUPPLY REDUCES DEATH RATE

Progress in water purification was so rapid, however, that its opponents were soon silenced and waterworks engineers everywhere

devoted their attention to the development of the science. So many engineers working independently caused the problem to be approached from various angles, so that almost every conceivable sort of objectionable water was brought within the range of study.

### COAGULATION AND SEDIMENTATION

Practically all of the cities drawing their supply from the turbid streams of the Middle West were at first directing their energies towards obtaining clear water, without concerning themselves much about the removal of bacteria. Louisville and Cincinnati were trying to filter the Ohio River water, first settling it with or without coagulants. Quincy, Ill., was filtering the water of the Mississippi after it had been coagulated and settled through the use of lime and iron sulfate, and was getting excellent results in 1903. Kansas City, having no filters, was using alum as a coagulant for settling the muddy Missouri water in its basins.

The example of these last two cities encouraged St. Louis to attempt the clarification of the Mississippi River water by the use of lime and iron sulfate as coagulants, followed by sedimentation in large basins. After more than half a century of dissatisfaction, reproach, and ridicule over the muddy water, the first practical step was taken in March 1904, and for the first time in its history the city was served with comparatively clear water.

In 1882, Mark Twain, after 21 years of absence, returned to St. Louis, where he noted many changes, but of the water he wrote: "Here was a thing which had not changed; a score of years had not affected this water's mulatto complexion in the least; a score of centuries would succeed no better, perhaps." On his visit to the city in 1908, to his great surprise, he found the water clear.

Following the initial treatment in 1903 came some ten years of effort to perfect a process of purification without the use of filters. The idea was finally abandoned, and the Chain of Rocks filters were built in 1914 and 1915.

### LOUISVILLE DISCOVERS FILTERS REMOVE BACTERIA

Water purification in this country may be said to have

FILTER ROOM IN CHAIN OF ROCKS PLANT

actually been put in practice in 1872, when the first filters were built in Poughkeepsie, N.Y. These were of the slow-sand type, of which the first one was built in 1829 for the Chelsea Water Company, one of many corporations supplying the city of London. There is a tradition, however, that the Chelsea filters were patterned after those of Glasgow, Scotland. The English type of filter was, however, utterly useless for the turbid waters of the Mississippi Valley.

In 1897, the City of Louisville, Ky., concluded a no-

MIXING CHAMBER AT HOWARD BEND PLANT

table investigation, which eventually resulted in perfecting the design of the first American or rapid-sand type of filter. It was a number of years before the full significance of this work became evident. Louisville's first aim was to clarify the water, but it was soon discovered that settling out the mud removed the greater part of the living organisms in the water.

### PUBLIC HEALTH IMPROVED

A few years later the clarification of the St. Louis water supply by coagulation and sedimentation brought about a surprising improvement in the public health of the city, although the treatment of the water was primarily undertaken for the sole purpose of improving the appearance of the water, so that the expected visitors to the World's Fair in 1904 would not be astonished at the sight of the muddy water to which the inhabitants had long been accustomed.

Increase in population along the shores of the Great Lakes and on the streams tributary to them created a danger which seemed to spring up almost over night. Buffalo, Cleveland, Detroit, and many other cities have built filters to avoid the continual extending of intakes farther from shore and the danger that contamination might at any time extend beyond them. Chicago is now planning to build filters, as all other communities depending on the Lakes for their supply must sooner or later do.

There are many communities whose water supplies are drawn from sources other than rivers and natural lakes, whose problems are just as perplexing and whose solutions are often far more costly than those already mentioned. Many cities grow so rapidly that the quantity of water becomes inadequate and threatens to stop all progress, making it imperative to find an additional supply at any cost.

Between 1840 and 1906, New York City had developed

the Croton watershed, lying about 50 miles north of the Battery, to its utmost capacity. Long before this latter date it became evident that the city must have more water, and the construction of a great system was started to bring it from the Catskill Mountains, some 100 miles away, at a cost of more than $200,000,000. Of this great work it has been said, "There is no more complicated and extensive engineering work in the world."

COAGULANT HOUSE AT HOWARD BEND PLANT

With this project scarcely finished, it has been found necessary to acquire additional watersheds to augment the Catskill supply.

Los Angeles went 235 miles to the Owens Valley for its water and now proposes to bring an additional supply from the Colorado at an estimated cost of $225,000,000. The Hetch-Hetchy project for bringing water to San Francisco through more than 150 miles of tunnels and steel pipe is now under construction.

CHEMICAL TREATMENT

A great forward step towards safeguarding the public against water-borne diseases was taken in 1908, when the water supply of Jersey City was treated with hypochlorite of lime. This was the first time this chemical had been used as a continuous or permanent method of water purification although it had been used at least once before, with good results, as a temporary expedient during a typhoid epidemic in England.

The use of hypochlorite of lime, later superseded by liquid chlorine, rapidly spread over the country, both as a precautionary measure following filtration or clarification, and also for the sterilization of water taken directly from lakes or clear streams. Chlorination is now regarded as necessary at all water works to insure adequate freedom from bacteria.

Twenty years ago the action of the United States Public Health Service in starting an investigation into the sewage pollution of interstate waters and its effect on the prevalence of typhoid fever materially helped the general advance in water purification.

With accurate knowledge of methods of water purification easily available and with well developed appliances for water treatment readily obtainable, it would be natural to conclude that epidemics from water-borne diseases and from typhoid especially, would be no longer possible. Unfortunately this is not the case. During the last ten years there have been more than two hundred epidemics traceable to water supplies, which, on investigation, were found to have been caused by the use of untreated water, by failure of automatic purification devices due to careless or improper operation, or by contamination after the water had left the treatment plant.

The courts have held that when the city takes over the business of supplying water to its inhabitants, it enters

CHAIN OF ROCKS PLANT, ST. LOUIS WATER WORKS

the field of private business and as a consequence must be held liable for any injuries its activities may cause. The now generally recognized fact that communities must be supplied with pure water, forms one of the strongest arguments that could be presented for municipal ownership of this particular public utility because the one thing that is an absolute necessity, for which there is no substitute, and whose universal use directly affects the public health, should not be allowed to be controlled by private interests and made an affair of pecuniary benefit to them—a thing with which to speculate and upon which to trade.

REMOVAL OF TASTE, ODORS, AND COLOR

Under the head of water purification comes the removal from natural waters of objectionable features other than dangerous bacteria and suspended matter, such as disagreeable tastes and odors, excessive hardness, or color, the presence of iron and manganese, or a high content of carbonic acid or hydrogen sulfide. These are by no means of universal occurrence, and the special treatment necessary in each case is well understood, and is usually applied along with the general treatment for clarification and filtration.

There are many things connected with supplying water to cities and towns that require as much knowledge and study, and in themselves are just as important in solving the general problem as water purification, but they have not been so prominently in the foreground during the last 20 years. Among them are the design and construction of intakes in rivers and lakes, of tunnels, of dams for impounding reservoirs, of aqueducts, pumping plants, settling basins, filter plants, stand pipes, distribution systems, and a host of other items, each one of which involves a world of detail, about which volumes have been written, and which are continually undergoing revision and change.

Just as the practice in all these things progresses, so will the science of water purification approach greater refinement. As the city itself grows and is never finished, so must water works be extended and kept well in advance of the present demands. Unfortunately, in most cities the usual municipal administration practice of postponing action on matters not requiring immediate attention has prevailed, partly on account of the uncertain tenure of public office and partly because the glory of an achievement is likely to be claimed by a later incumbent. Here in St. Louis a systematic and continuous campaign for new water works was carried on for ten years, from 1913 to 1923, through the local press, in technical journals, and from the lecture platform, before bonds were voted for the Howard Bend Plant, lately completed.

### Men of Vision Required

Not only should there be men well versed in all the technic of water supply, from its source to the consumer, in charge of municipal water works, but they should be men of vision, intensely human and just, with courage to resist the pressure of all influences that would tend to impair the efficiency of a well organized department. Any person, no matter how incompetent, if given unlimited time and money, may produce passable, if not creditable results. But that is not engineering; it is closely akin to criminal waste.

Filter House at Howard Bend Plant
St. Louis Water Works

# Natural Water Courses as Municipal Assets

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Rainfall, a necessity for a rural community, is not without benefit to a city. But the problem of draining away the excess rain water from an urban area too often presents serious difficulties. The construction of adequate drainage facilities for handling the run-off necessitates the placing of charges against the land which are detrimental to its best use.

In many instances land worth less than \$1,000 an acre is so situated that more than \$2,000 an acre must be spent on it for drainage, part of which will be spent prior to occupancy and the balance later. This seems an excessive proportion of the value of the raw land, and the resulting development is not necessarily compatible with either sound economics or with satisfactory esthetic or cultural considerations.

When, in the early years of this country, cities were growing up along the waterfronts and watercourses, the most valuable property was always the waterfrontage. Under this economic stress, creeks and gulleys were walled up and then covered. Many of the storm sewers of our big cities today are of this type, at least in their lower reaches. The great Mill Creek Sewer in St. Louis, begun in the late fifties, built almost in the bed of another stream, was given its impetus because of the supposed necessity of draining Chouteau Mill Pond, ostensibly because it had become polluted by sewage, but undoubtedly in a great measure because of the pressure for more land "close in."

We cannot question the economic soundness of these operations under the then-existing conditions of city life, but what would it not mean to the St. Louis of today for relief of congestion if these areas so extensively drained could be reproduced in their original condition?

Up to the period of the Civil War and on into the eighties, transportation conditions did not change appreciably. Our steadily growing cities, spread out in all directions, were always building solidly and densely with each new acre brought in as close as possible to the center. To accomplish this, we not only cut down the forests and graded off the hills, but filled the ravines and water courses and continued to build great artificial waterways for storm flows. The cost of these artificial waterways increased steadily, not only from the general rise in all costs, but because engineers found that early experience with storm run-off had given an inadequate picture of the peak flows which could come from excessive storms falling on areas no longer wooded or grassed, but covered almost solidly with roofs, walks, and pavements.

With the coming, first of cable and then of electric cars to supersede the slower horse-drawn vehicles pressure for "close in" occupancy was relieved, and the development of our outlying civic centers and satellite communities was noticeable.

Recent years have seen the burden of transit swing to the gasoline vehicle, first in the shape of the private

AN APPLICATION OF THE "IDEAL SCHEME" FOR DRAINAGE

In this illustration and in the one on the opposite page are examples of the application of two methods of handling the excess run-off from parts of the same water course in St. Louis County. Here, the original water course is shown undisturbed and the lowlands are unoccupied by any improvement of value except that an intercepting sanitary sewer parallels the creek.

car and later also of the bus. Urban expansion, long bound in concentric rings to the original city and then released in long disconnected strips along the car lines, is now free to wander afield. This new tool of the people has made the home-owner independent of distance, which is permitting him to go out a long way, and also of fixed routes of transportation so that he is at liberty to settle down in any part of the surrounding country where there is a road.

It seems no longer needful that the advancing community occupy with industries or residences each section it reaches, but the best and most adaptable may be taken and the rest put to other use. This allocation, however, cannot be a matter of arbitrary decision as it is intimately connected with the development of a proper drainage policy. Drainage and sanitation must be furnished over a wide area and under conditions radically different from those which have established the policies of the past.

This regional drainage is being developed under several different conditions of control. In many instances the decentralized community has spread beyond the shield of any existing municipal corporation and the working out of drainage and other utility problems is in the hands of large realty operators. In other instances, these problems have been faced by county authorities and a new type of function for a county government has resulted, sometimes with most unfortunate results because of inexperience; but occasionally the opportunity for originality has been grasped with rather brilliant and startling results. Finally, much of this newly occupied land is within corporate limits and existing engineering staffs and executive boards are undertaking to provide for sanitation.

It has seemed to me that the ideal drainage plan must involve a separate scheme, of which the first part is an amply designed sanitary system. This should preferably be complete and separate from all storm drainage and generally free from interceptors and overflows. However, it might be well to avoid that bête noir of separate sewerage, the dual house connection, by accepting down-spout connections as inevitable and designing the sanitary system for roof water. Where disposal is by dilution, this results in some increased cost of trunk sewers but affects laterals very little. Where purification is required, an overflow of the storm water is unavoidable.

An ideal storm-water system will use, to the greatest practical degree, the natural drainage and reduce the construction of artificial storm sewers to a minimum. Storm sewers should act merely as outlets for catch basins at street crossings and they should extend only to a point of discharge into the nearest ravine or rivulet susceptible of preservation. In general it would be more economical to spend money for the acquisition of natural waterways than for the construction of large storm sewers.

The extent to which this "ideal plan" might be realized would depend upon the condition of the watershed as to platting and occupancy at the time control is secured. Looking backward for an illustration to the Mill Creek Valley in the heart of St. Louis—municipal development progressed up the valley for 40 years until the whole 5,000 acres was settled in 1890. The construction of the main trunk sewers, carried out gradually through this period, cost about $2,500,000. If the annual outlays for sewer construction had each been advanced ten years and had been used for the purchase of land, the

THE WATERWAY REPLACED BY A STORM DRAIN

Here the lowlands of the same stream have been filled up 8 or 10 ft., a large storm sewer constructed to replace the stream, and the adjacent hills have been graded down. If the valley had been left open, the cost of grading and drainage which would have been saved would have more than paid for an equivalent area for occupancy elsewhere.

available amounts would have acquired not only the natural stream and its overflow lands but would have been sufficient to purchase every acre in the whole watershed.

We are proud of the great Des Peres Drainage System in St. Louis. It is curing a fearful condition, but is our future sewer policy to be one to prevent a recurrence of such critical conditions, or will it bring us to the more frequent expenditure of materials for artificial drainage as we expand? The large closed sewers of the Des Peres System cost over $200 a linear foot. Thirty years ago one-tenth of this sum, or $20 a foot, would have been sufficient to purchase a strip a quarter of a mile wide up the valley and would have prevented development in the lowlands, while a like amount spent in channel improvement would have reduced flooding to an unobjectionable amount.

For restricted residential developments, applications of this plan have been seen in a small way in the suburbs of almost every large city. Particularly interesting examples of it are in Dallas and Kansas City, the result of private enterprise. In Westchester County, New York, a somewhat similar result is being secured on a large scale by the reverse of this plan, that is, by the taking over of the valleys as parks and parkways, which need no extensive drainage.

In contrast, the "ideal plan" would take over the valley lowlands as "drainage ways." This might not prevent the use of them for other not inconsistent municipal purposes such as parks and parkways, and in favorable places, as playgrounds and recreation reserves. In some instances, too, the original arrangement might be subject to modification. For example, if the valley is to be developed industrially, as when a railroad is run through it, the bottom lands might be relieved of the flowage easement by further channel improvement, carried out either by the governing body or by licensed industries. But even then the main improved channel would, of course, remain as the official drainage way of the municipal corporation.

Acquisition of the valleys as drainage ways well in advance of development would not alone affect economic drainage, but many other collateral advantages would follow. For example, the dumping of rubbish over our landscape would have to cease and we would be forced to develop the collection and disposal of household waste through some more business-like system. Land along the drainage ways would be available for parks and recreation. Light-traffic, high-speed thoroughfares would follow the valleys, as is being done so well in Westchester County, but most important of all, large open spaces would have been reserved and low-density housing would result.

While the surrounding region in St. Louis County has sewers in only a few of the borderland towns, the city of St. Louis is substantially and completely sewered. The remainder of the area is seriously unsanitary. Under new legislation, a system of sewers for some 25,000 acres, estimated to cost $15,000,000, is now being discussed. The plans are complete, but their carrying out is apparently awaiting the settlement of political differences. It was my privilege to act as consultant on the whole of this system and to assist in devising an economical plan to suit conditions as they varied from point to point.

Generally, in the inner zone, development has pro-

ceeded so far that nothing but an extension of the combined system of sewers on the St. Louis plan was possible. In the outlying sections opportunity was presented for something different and the adopted plan for a considerable part of the Central District and some parts of the Jennings District approach the ideal scheme which I have suggested. But it was in the St. Ferdinand District, embracing nearly the whole Maline Valley land, that platting and occupancy had not developed far outside of a few centers, and the designer had free opportunity to choose a drainage plan. The supervisors of this district, appreciating all of the advantages which have been outlined, adopted a plan very nearly approaching the "ideal scheme."

# Coordination of Terminals

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IN THE modern scheme of transportation, terminals are necessary for the receipt, discharge, and interchange of traffic, and traffic means the movement of both people and commodities, usually referred to as passenger and freight traffic. I will endeavor to point out some of the principles governing closer coordination of this movement, rather than the details of operation.

Passenger traffic or travel, either for business or pleasure, has become a feature in the lives of people today to an extent never before experienced in history. In fact, rapid transportation has been perfected only within the last hundred years, the period covering the development of the railway and steamship, and it is only within the present generation that travel by aircraft and motor bus has been developed. Naturally, with so much time spent by so many people in travel, it is important to save unnecessary delays, and terminals are designed for the expeditious and convenient movement of travel through important gateways.

Photograph Charles F. Doherty

KANSAS CITY UNION STATION FROM THE SOLDIERS MEMORIAL

COORDINATION OF PASSENGER TERMINALS

In the City of St. Louis we have a very good example of the coordination of railway passenger traffic. All trains arrive at and depart from the same station, and the operation of trains within the terminal zone is handled by a single agency; that it is satisfactory and efficient is the universal verdict of travelers through this gateway.

This same principle is being applied to other cities, such as Washington, Kansas City, Denver, and Dallas, where a single operating agency is handling the passenger business. It is, however, impossible to have only one station in every large city. Topographical conditions, which very largely fixed the locations of railways, lead to the grouping of railways in certain areas. Thus Boston has two large stations, New York has two, and Chicago will eventually have perhaps three.

In considering the question of a single union station for Chicago, a commission headed by the late John F. Wallace, Past-President Am. Soc. C.E., pointed out the fact that the volume of traffic through a single station in a city as large as Chicago would congest the streets in the vicinity of the station to such an extent as to seriously interfere with street traffic; and it seems, therefore, that a station with about 36 tracks is near the limit for practical purposes.

In the handling of passenger traffic through a terminal where direct connection cannot be made with outgoing trains, a very good example of coordinated service is afforded by the bus line run by the Baltimore and Ohio Railroad Company, to take passengers from its bus terminal at 42nd Street and Lexington Avenue, New York, near Grand Central Terminal, to its Jersey City terminals. Stopping en route at central points in New York City, buses proceed directly onto the ferry boat, which crosses the harbor to Jersey City, and thence they continue to the waiting train in the train sheds. This movement by bus and boat is one of pleasure rather than inconvenience, as it affords a magnificent view of the sky line of New York City from the harbor front.

In large cities, in addition to the ticket offices at stations, the railways maintain ticket offices in the center of the business district, sometimes in the form of consolidated ticket offices. Where separate offices are

maintained, they are usually grouped in one block for the convenience of the traveling public.

HIGHWAY TRAFFIC INCREASES

With the development of the highway system of the country, it is evident that travel in the future will be by motor vehicles, buses, and private automobiles to a much greater extent than in the past. In fact, it is predicted by some that within a very few years the volume of traffic on the highways will exceed that on the railways.

Up to the present time the bus business has been in a somewhat unsettled condition, few companies having good equipment or financial responsibility, and there is now not much coordination between the various companies. Bus terminals, which should be in close proximity to the central passenger stations, are just being developed. It is not improbable that in time the greater number of companies operating buses will be under the control of the steam railways, which are finding that service to some sections of the territory adjacent to their lines can be given adequately by bus much cheaper than by branch steam lines.

UNION STATION, WASHINGTON, D.C.

With the increasing volume of travel on the highways, a need has arisen for highway stations or terminals. This need has been foreseen by the Pierce Petroleum Corporation of St. Louis, which has established certain highway terminals, where people traveling by their own vehicles may stop at points outside cities and continue their journeys around them. These road terminals have all the facilities that travelers require—good hotels, restaurants, laundries, and a complete garage service—and they will doubtless be greatly extended.

NEEDS OF AIR TERMINALS

Airport terminals, because of their great size and requirements for level ground, will always be outside city limits, and connections with them will be made, as at present, by motor vehicles. A number of important railways are acquiring financial interest in air routes and are coordinating their passenger service as to schedules and connections.

In travel by steamship, terminals have been fixed by nature, at ports with sufficient depth to accommodate shipping. The piers to which ships can load and unload are also necessarily fixed, so that it is not always possible to have railway connections, in which case motor vehicles form the connecting links between ships and stations. A lighterage service is also maintained between railway terminals and ships' sides, where the railway terminals are necessarily some distance from the piers. In many cities the docks are municipally owned and handling is through the port authorities. However, keen competition between various cities for ocean traffic results in good service being given.

DEVELOPING OUR INLAND WATERWAYS

With the development of the inland-waterway system of the country, it is important to have connections with the barge lines and river steamers. These river terminals are being provided generally at municipal expense and consist of wharves parallel to the stream, with railways, warehouses, and transfer cranes. Such terminals will become of greater importance as the channel depths of our rivers are stabilized and the service becomes dependable. In time, probably a great volume of heavy commodities will be handled on barges, and some more widely coordinated movement between the railways and the barge lines may be worked out. There are some transfer boats, as they are called, plying across the Great Lakes, and a service of this kind is maintained between Key West and Havana, and between New Orleans and Havana.

FREIGHT TERMINALS IMPORTANT

Freight terminals of American railways were generally established as close to the business districts of the cities as possible in the days when freight was handled to and from depots in horse-drawn wagons over poorly paved streets. As each railway deemed it necessary to establish its own terminals, we find very valuable areas in the hearts of our cities given over to the handling of freight. With good paving and quick-moving motor trucks, it is no longer essential to have these depots in the hearts of cities, and it seems advisable to move them from the business centers. Certainly interchange should be done in outer group yards and switching through cities and across streets minimized as much as possible.

While railways are willing to coordinate their passenger terminals, keen competition in the handling of freight has led them to look with disfavor upon anything like coordination in the movement of freight in terminals, but this is a development that will undoubtedly come in the future.

We have recently seen extensive coordination of the express business of the country. Many years ago there were numerous express companies, sometimes all serving the same territory. Now practically the entire express business of the country is handled by the Railway Express Agency.

In America, to a much greater extent than elsewhere,

the railways preceded the development of the country, and many large cities grew up around the original railway intersections or depots. This is particularly true of our Western cities, such as Kansas City, Oklahoma City, Tulsa, Fort Worth, Dallas, and even Chicago. In Europe, on the other hand, railway terminals had to adjust themselves to the cities. Paris is a good example of this, its terminals having been kept outside the heart of the city so as not to mar its beauty. The four principal terminals, serving roads leading to the north, south, east, and west, are connected by a subway system, as well as by surface lines and taxicabs.

The American railroad has been developed entirely upon the competitive theory in business, and there has been a tendency for each carrier to provide all its own facilities, with constant enlargement and rearrangement. It has been taken for granted that traffic would continue to expand, but we have seen in the last few years a steady decline in passenger traffic on the railroads and it is likely to continue, because the buses and privately owned automobiles will continue to handle increasing numbers of people. In a few years, great inroads will have been made on long-distance passenger traffic by the airplane.

We are also finding out the painful fact that freight business can contract as well as expand. This year of 1930 will see a reduction of about 25 per cent in the volume of freight moved on the American railways, as compared with 1929. The facilities of the country do not require further expansion. What is needed now is close cooperation rather than competition between carriers, and this can be secured first in the terminals, by pooling the existing plants under central agencies, for the handling of freight as well as passenger business. A great saving could be made by the relocation of freight houses.

### CONSOLIDATION OF RAILROADS

It has been claimed that transportation service will be improved by the consolidation of the railroads of the country into a limited number of systems. Legislation has been passed in Congress providing for this, and the Interstate Commerce Commission has suggested the tentative grouping of the carriers. This has been referred to in Presidential messages. It has been urged that economies in operation and great savings in terminal expense, leading to cheaper transportation, would result.

But there is a question as to whether it is desirable to group the railroads into large systems, which might become so large that the executives would not be able to keep in direct touch with the operation of their lines to the extent possible with smaller systems. It would seem that, if the terminals could be consolidated, all the advantages of consolidation might be secured without any of the disadvantages. If the terminals of the country are formed into associations such as the one prevailing at St. Louis, and the agency enlarged to include the handling of freight, a decided improvement would be made in the transportation system, and duplication of both facilities and effort would be prevented.

# Municipal Partnership in Mass Transportation

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THE very existence of the average large American city may be said to depend on the efficiency of its several agencies of transportation. Such cities usually have relatively small and centralized "congested areas" where great numbers of people congregate during the working hours of the day and where the maintenance of the current high property values, through proper transportation facilities, is, as society is now organized, essential to local prosperity. Ten American cities have recently spent over $2,000,000 in merely studying their mass transportation problems.


SEGREGATION OF TRAFFIC ON BUSINESS STREET

The whole transportation problem is particularly perplexing just now, because it must be approached in the face of changing and uncertain economic conditions, and because the engineering, economic, and administrative problems involved must be studied against the confusing background of mass sentiment which, in a democracy, goes by the name of "practical politics." There-

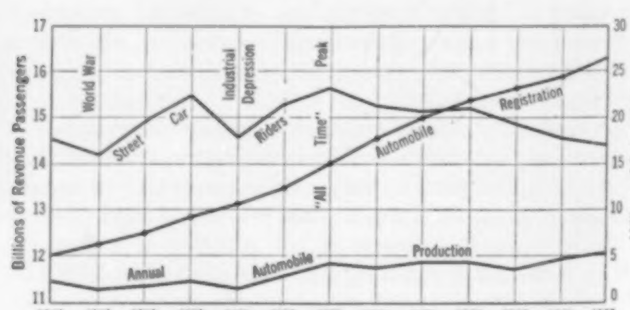


FIG. 1. TREND OF STREET CAR TRAVEL

fore, the engineer called upon to recommend a solution for a city's mass transportation problem must be governed by both political and economic expediency, as well as by technical engineering considerations, if he expects that his recommendations will be of any real help.

COMPARISON OF TRANSPORTATION FACILITIES

The organized agencies for furnishing this transportation are the suburban lines of the steam railroads, subways, elevated railways, street railways, buses, including trackless trolley cars, and taxicabs, with an unregulated, financially irresponsible, and limited service furnished by "jitneys."

A comparison of several methods of transportation in the average American city, under average conditions, is shown in Table I.

Elevated railways are not referred to in this table, because they are essentially a feature of urban rapid transit and can perform the same class of service with the same degree of efficiency as subways, if they are modernly constructed and equipped, so what has been said of the carrying capacity of subways and speed applies equally to elevated railways, at a comparable cost of $2,250,000 per double-track mile. The popular objections to elevated railways are for reasons unconnected with their service capacities.

Taxicabs have materially increased in number during the last few years. In New York, 22,500 are registered, with 20,000 of these estimated in daily operation. They perform a special and somewhat unregulated service which, in capacity and similar characteristics, is not comparable with the other organized agencies of mass transportation.

Beyond these few pertinent points of comparison, it is not my purpose to discuss the merits and necessities of rapid transit. However, it might be of interest to speak briefly of the recent trend in electric street railway travel.

ELECTRIC STREET RAILWAY TRAVEL DECREASING

This type of transportation represents an investment of approximately five billion dollars. Its continued suitability under modern conditions is the subject of much discussion, but it still remains an important agency in mass transportation in most of our large cities. In spite of population increases, street car travel in the past few years has shown a steady decrease, and the necessity


MUNICIPAL AND COMPANY COMPETITION
Market Street, San Francisco

TRAFFIC SEGREGATION SPEEDS UP STREET CARS
Delmar Boulevard, St. Louis

AN APPALLING WASTE OF TIME
Olive Street at 10th Street, St Louis

FRANKFORD ELEVATED RAILWAY—PHILADELPHIA
Cruciform support, concrete deck, ballasted track, minimum noise and street traffic interference

My personal opinion is that in many of the smaller cities, and on some routes in the large cities, street cars have definitely become obsolete; first, because the private automobile has taken away permanently many of their passengers, and second, because the remaining passengers can be more economically handled by buses. But I still firmly believe that, in many of the larger cities, excluding certain portions of Greater New York, the principal agency of mass transportation is still, and for a long time will continue to be the street car. Even in Greater New York, street cars play an important part, as these figures of passengers carried during the year 1929 show:

| | |
|---|---|
| Subway and elevated lines.......... | 2,018,319,690 |
| Street car lines.................... | 988,675,620 |
| Suburban railroad lines and ferries... | 422,898,285 |
| Buses.............................. | 111,206,916 |

TABLE I. STATISTICAL COMPARISON OF TRANSPORTATION METHODS

| | Subways | | Double-Track Street Railways | | Buses | |
|---|---|---|---|---|---|---|
| | 4-Track Combined Express and Local | Double Track | In Subways | On the Surface | Double-Deck Buses | Single-Deck Buses |
| Passengers carried per hour in one direction | 60,000 | 36,000 | 20,000 | 13,500 | 8,000 | 4,500 |
| Capacity efficiency . . | 167% | 100% | 56% | 38% | 22% | 13% |
| Speed in miles per hour | 23–24 | 16–21 | 16–18 | 10 | 9 | 12 |
| Construction cost . . | | $5,500,000 per mile | | $180,000 per mile | $12,500 each | $10,000 each |

for rapid transit construction must now be based on grounds other than insufficient surface facilities.

The 1930 Census shows that in the ten largest cities of the United States, excluding New York, because it can hardly be compared with other American cities, the population has increased approximately 30 per cent since 1920. But in these same cities, between 1920 and 1923, there was an increase of only $3^1/_2$ per cent in revenue from street car passengers, or slightly over 1 per cent a year. From 1923 to 1929, the last full year's figures available, there was a decrease of 8 per cent. From 1920 to 1929, the decrease was $4^1/_2$ per cent, which figure is approximately comparable with the population increase of 30 per cent.

There is no doubt that this decreasing trend in street car travel is due entirely to the increased use of the automobile, Fig. 1, which cannot be ignored in any future consideration of transportation. The question is, when will the saturation point in automobiles be reached, and when that point is reached will the trend of street car travel again be upward?

Undoubtedly the efficiency of street cars in many instances should and can be materially improved by placing them underground in congested districts—as Boston did in Tremont Street in 1897, and as Philadelphia has done—and by traffic segregation and regulations.

The automobile has been a factor in causing cities to spread, and transforming a substantial percentage of the American people from urbanites to suburbanites. For instance, the 1930 Census shows that in New York City, the Borough of Manhattan actually decreased in resident population 18.6 per cent in the last ten years, but the other outlying boroughs increased an average of approximately 70 per cent. In St. Louis, nearly the same thing has happened. Within the city limits the increase was only 5.8 per cent, but in that portion of St. Louis County adjacent to the city the increase was 114.7 per cent.

This tendency in the average American city has lessened the population density, and therefore diminished that factor which makes economically possible, on a self-sustained basis, the adoption of rapid transit facilities, because to adequately serve this larger area requires the construction of too much mileage. At the same time, the automobile and high speed elevators, and consequently higher buildings, have increased the working-day density of certain portions of our cities to almost the unbearable point. This fact, combined with the psychology of faster movement, has created a widespread public demand for rapid transit, without a proper con-

Broad Street Subway—Philadelphia
Showing Tunnel and Track Construction—Walnut-Locust Station

sideration of its cost, and with a neglect of proper traffic regulations and other improvements, which in the meantime would not only increase the speed of the present surface facilities, but also improve the convenience of automobile traffic.

Although this uncertain and adverse traffic condition has grown up rather recently in all American cities, in most of them the old political situation remains. The street railways are excessively and inequitably taxed; they are burdened with unjust paving requirements; they are the victims of unfair and fraudulent damage claims; and are not sufficiently aided by proper traffic regulations, largely because the public, the newspapers, and the politicians still regard them as the old-time profitable octopus. But not so with the investor. A well known investment counsellor, over the radio, recently advised the public against investment in street railway securities, and today a franchise of the old type is regarded as only better than no franchise at all.

Confronted by this situation, "a condition and not a theory," the average citizen travels in urban territory with inconvenience and discomfort and with appalling waste of time, regardless of the agency he uses. The engineering solution is relatively easy, but how is the economic and political situation to be met?

Possibly a solution is suggested in a statement of President Lowell of Harvard University, expressed 20 years ago in his *Public Opinion and Popular Government*, when he said, "People like to know that they are governing themselves, as well as to feel that they are being well governed."

### A CITY-COMPANY PARTNERSHIP PLAN

This characteristic of the American people may account for the politician's frequent suggestion of municipal ownership and operation. But to municipal operation there is undoubtedly a widespread opposition because of its fundamental evils and actual examples of failure. But there is an intermediate ground, which may be called a partnership between the city and privately owned railways. Certainly the present stagnation in development will be lessened and such silly competition between municipally owned and privately owned railways, as is illustrated in San Francisco, where four tracks block one of its principal thoroughfares, will be eliminated.

In general terms, a street-railway municipal partnership could be carried out as follows:

1. The city should purchase all the physical properties and assets of the railway company at a price to be agreed on.
2. The city should refund all existing mortgage securities, with city bonds secured, not by the general credit of the city, but only by a lien on the property of the street railway. These bonds would be a municipal obligation, and as such their interest payments would be free from Federal and State income taxes. Such bonds should therefore have a market value not now enjoyed by ordinary street-railway bonds, and the financial situation thereby improved by a measure of the city's credit.
3. The city should lease the railway properties to the selling company to be operated by the company until the city should pay to the company the balance of the purchase price, which would be the difference between the amount of the above bonds and the price agreed on in Item 1. This balance should bear interest at an agreed rate.

After deducting the operating expenses of the operating company from the gross revenue, the balance left for disbursement annually under the above scheme would have been formally represented by: the taxes paid to City, State, and Federal governments; the amount annually set aside as depreciation; the amount paid as interest on obligations; any dividends paid; any annual surplus.

The total of these amounts would then be disbursed as follows: interest on the city's street railway bonds; annual sinking fund on these bonds; an amount to be paid the city in lieu of the former taxes which it col-

WHY DOWNTOWN SUBWAY CONSTRUCTION IS EXPENSIVE
Looking South on Nassau Street, New York

lected on the street railway property; interest on the balance of purchase price owed stockholders; that portion of the former depreciation "set-up" which it is actually necessary to spend on the property each year in replacements in order to properly maintain it; and surplus.

These proposed disbursements save two former items of expense, to wit, State and Federal taxes, and that portion of the former depreciation "set-up" which represented obsolescence, but not current replacement expenditures. These savings it is planned to spend on the annual sinking fund for the bonds and ultimately in liquidating the stockholders' equities. If the net revenues prove to be insufficient to meet these proposed disbursements, then the deficiency should be taken on an equal pro rata basis from the amount paid annually to the city and from the amount paid to stockholders as interest on the balance of the purchase price, and conversely, if there is a surplus, it should be divided on the same basis between the city and the stockholders, less an arbitrary deduction which could be used for extensions or improvements, and thus for the immediate general good of the public, or as interest on capital financing of improvements. Such an arrangement for disbursing the net revenue would give the stockholders, the city officials, and the general public an interest in the efficient management of the railways.

From the standpoint of the investor, in addition to certain tax exemptions and a certain moral responsibility of the city, the depreciation and other reserve funds could not be used to pay dividends, thereby creating a present false value for his security, but leaving him with the "bag to hold," as might be the case at the termination of a definite and uncontrolled franchise.

From the standpoint of the city, it would enjoy a more direct and flexible control over its local transportation, and be in a better position to meet demands for steps in the direction of rapid transit. It ultimately would be the owner of the transit property without financial obligation on the part of the city, although this might not be for a generation or so.

It has been said by Justice Holmes, of the United States Supreme Court, that: "To be master of any branch of knowledge, you must be master of those which lie next to it; and thus to know anything you must know all." Realizing that I do not know "all," or even any appreciable part of "all," it is with hesitancy that I have made a recommendation for a municipal-company partnership, which in fact is a deferred-payment purchase plan, and would, in the case of St. Louis, result in city ownership and operation in about 35 years unless at that time modified by an extended lease. This recommendation is made in spite of a previous prejudice against government entering any form of business, which amounted almost to a point of principle with me.

## PROGRESS

"He who is silent is forgotten; he who abstains is taken at his word; he who does not advance falls back; he who stops is overwhelmed, distanced, crushed; he who ceases to grow greater becomes smaller; he who leaves off, gives up; the stationary condition is the beginning of the end."

—*Henri Frederic Amiel*

# Improving the Brazos River

*New Outlet Relieves Freeport Harbor of Flood Menace*

*By* Milo P. Fox

Major, Corps of Engineers, District Engineer, Galveston, Tex.

FREEPORT Harbor is located just inside the mouth of the Brazos River, Tex., which empties into the Gulf of Mexico about 47 miles southwest of Galveston. While the town of Freeport, Tex., is comparatively a recent development, work on a channel and port at that locality has been going on for a long time. In 1881, the Federal Government undertook to establish and maintain a channel, but abandoned the project in 1888. The following year a private company took up the work and continued until 1899, when it in turn yielded in favor of the Federal Government, which has continued operations under various plans up to the present time.

*THE BRAZOS River is unique in that it has but one natural mouth. The 6-mile artificial outlet was not excavated to the full dimension of the river channel, but it is expected that flood flows of the stream will create between the protecting levees such section as it requires. The new outlet is a mile and a half shorter than the natural course of the river, and the resulting disturbance on its hydraulics will be watched with great interest by engineers concerned with river control. In a paper here abstracted this unusual harbor development was described before the Waterways Division at the Fall Meeting of the Society in St. Louis, October 2, 1930.*

Floods of the Brazos River have been the source of ever-increasing difficulties, and have made the cost of maintaining the harbor unreasonably high. As a consequence, in 1923, the Government was considering the abandonment of the project. Fortunately, before such action was taken a new study was made, which resulted in the adoption of a new and somewhat unique project, calling for the diversion of the waters of the lower river through an artificial channel to a new coastal outlet.

#### BRAZOS CARRIES QUANTITIES OF SILT

The Brazos River is one of the largest and most important rivers of Texas; its relation to the other rivers of the State is shown in Fig. 1. Its source is about 40 miles west of the Texas—New Mexico line, from whence it flows in a southeasterly direction across the State of Texas, and empties directly into the Gulf at Freeport. It is approximately 1,300 miles long and has a drainage area of about 41,700 sq. miles. At the Texas—New Mexico line, the elevation of the river is 4,000 ft. From this point, the slope gradually decreases from 6 ft. per mile to 0.44 ft. per mile in the lower 15 miles. The upper reach of the river, that portion above Waco (mile 430), flows through semiarid land, has an average width of 200 ft., and seldom overflows its banks. Below Waco it flows through a rich bottom land, has an average width of 500 ft., and is subject to overflow.

River Diversion and Dam, Freeport Harbor
Highway Swing Bridge Over Channel in Foreground

From the mouth up to a point about mile 15, the banks vary from 5 to 8 ft. in height, and from there up to Waco they vary from 20 to 55 ft. The banks below Waco are of sandy-loam material which erodes excessively during each rise. At the mouth of the river a shifting bar exists, which before the jetties were built had a depth of from 3 to 9 ft. From the bar up to mile 48 (Bolivar Landing) at low tide the controlling depth is 8 ft. Tidal influence extends up to this point. Beyond Bolivar Landing, as far as mile 260, the controlling depth is only 2 ft.

The river is subject to frequent rises, which may occur at any season of the year. Records show that between the years 1919 and 1924 an average of ten floods per year occurred. In the early days of improvement work at its mouth, the damage caused by floods was not nearly so great as in recent years. It is believed that formerly the waters deposited their sediment on the low lands lying along the river, which were inundated by every large rise, and returned to the river comparatively free of suspended matter. As agriculture developed along these rich bottom lands, they became more valuable, and more or less continuous systems of levees were built for protection against overflow. Probably as a result of this, the river was forced to carry a greater amount of sediment to its mouth, depositing it in the flat lower reach and on the bar. Tests made during rises show that suspended silt in the water reaching the mouth of the river amounts to from 5 to 10 per cent in volume. The difficulties resulting from the deposition of this silt are not hard to imagine.

#### FREEPORT HARBOR BUILT AT RIVER MOUTH

From 1881 to 1917, work to develop a reliable harbor was carried on intermittently and under various plans, at times by local interests, and at others by the Federal Government. The expenditures for maintenance and improvement up to 1917 were about $1,650,000. While for short periods there had been depths as great as 18

ft. available, the only permanent results obtained consisted of two rubble-mound jetties protecting the entrance to the harbor, one 4,708 ft. and the other 5,018 ft. in length.

Considerable development near the mouth of the Brazos had occurred during these years, notably the establishment of the town of Freeport, and the development of a large sulfur deposit. As a result, Congress authorized an experimental project looking to the construction and maintenance of a harbor with an entrance channel 150 ft. wide and about 22 ft. deep across the bar and in the river, leading to a suitable turning basin in the river below Freeport.

DREDGE STARTING CUT FROM BEACH LINE

Under this project the intermittent shoaling of the bar and channel caused great losses to shipping interests. It was necessary on several occasions to divert vessels destined for Freeport to other ports. In 1919, six days after a 20-ft. channel, 100 to 125 ft. wide, was completed, it showed a depth of 15 ft. The rise had occurred a few hours after the dredge departed.

In 1921, a vessel entered Freeport Harbor for a load of sulfur. When she entered, there was $18^1/_2$ ft. of water at mean low tide; before 3,000 tons of sulfur were loaded a rise occurred, silt was deposited around the vessel while lying at the dock and she would have been solidly embedded had not one of the sulfur company's vessels immediately ahead of her kept its wheel turning over and practically washed away the accumulation before it became fixed. By unloading some of the sulfur and emptying all her tanks, she was finally able to scrape over the bar during a very high tide.

These conditions existed after the Federal Government and private companies had incurred a total expenditure of around $3,000,000. It was obvious by this time that the project must either be abandoned or some different method employed to establish and maintain a harbor. Consequently, a reexamination of the project was authorized and new studies made.

### SIX PLANS PROPOSED

As a result of this examination, six different plans were proposed. They are shown in Fig. 2 and include:

1. Straightening of the lower river by a cut-off across Big Bend
2. Diversion of the river from the upper end of Big Bend through Jupiter's Cut
3. Abandonment of a deep water project in favor of a 9-ft. canal to Galveston, the construction of which had been authorized
4. Diverting the river at a point about 13 miles from its mouth through Jones Creek and the San Bernard River
5. Continuous dredging
6. Diverting the river westward at a point about $7^1/_2$ miles from its mouth, or just above Freeport

It will be noted that all plans for the diversion of the river contemplated turning it into the Gulf westward of the harbor. The advisability of this was clearly indicated by the fact that practically all of the silt and débris deposited by the Brazos was near the shore west of the river mouth.

Of the six plans contemplated, only two were considered acceptable. The War Department favored No. 2 because of its relative economy. Local interests, however, preferred Plan No. 6, and in accordance with the authority granted them by Congress in the act authorizing the improvement, were permitted to submit alternate plans, with the understanding that they should bear all costs in excess of $500,000 on any project that might be adopted. The plans and estimates submitted were prepared by the J. F. Coleman Engineering Company of New Orleans.

### GOVERNMENT APPROPRIATION ASSISTS CONSTRUCTION

Construction work on the diversion started August 25, 1928, and was completed September 13, 1929. During that period the work accomplished consisted of six separate operations.

An earth-fill dam of large section and flat slopes, composed of material dredged from the throat of the diversion channel, was built just below the point of diversion, as shown in Fig. 3. The core of this dam consists of an


FIG. 1. WATERSHED OF THE BRAZOS RIVER
With Relative Location of the Other Principal Rivers of Texas

interlocking steel, sheet-pile wall, extending 34 ft. below, and 12 ft. above mean low tide; the width of the crown is 110 ft. and the height 15 ft. above mean low tide; the depth of the river at the dam site was from 15 ft. to

30 ft. The dam is 1,100 ft. long, requiring approximately 360,000 cu. yd. of material.

A diversion channel was constructed beginning at a point about 7.3 miles above the river's mouth and extending to a point on the Gulf about $6^1/_2$ miles west of the mouth. The depth of this canal at the time of completion was $12^1/_2$ ft. The width varies, and therefore is best indicated graphically, as in Fig. 4. It will be noted that the first 2,700 ft. from the point of diversion is 450 ft. wide; this section is equal to or greater than the natural river at the diversion. Below, the width decreases for a considerable distance, increasing again at the outlet.

Levees on both sides of the channel were built by the hydraulic dredges with material excavated from the channel. It will be noted that the distance between levees is increased as the width of the channel is decreased. At the intake, the east and west levees are, respectively, 15 and 14 ft. high. The east levee is a continuation of the dam across the main river. This height is gradually decreased until, at the sand dunes along the Gulf coast, it is only 6.2 ft. The levees have a 12-ft. crown throughout and side slopes of approximately 1 on 20. Cross sections of the channel and the levees are shown in Fig. 5.

A drainage canal just outside of, and approximately parallel to, the west levee, was constructed to take care of the drainage from the land west of the diversion channel which was cut off by the west levee.

A highway bridge over the diversion channel was built by local interests. This bridge is 610 ft. long, including a 250-ft. swing span, and two fixed truss spans. The interesting feature in connection with this structure is that it was built on dry land before the diversion excavation reached that location.

From a point 3,000 ft. above the point of diversion, dredging was done in the river to round off the point on the west side, and form a guide channel into the diversion. The west levee was also extended upstream for 3,000

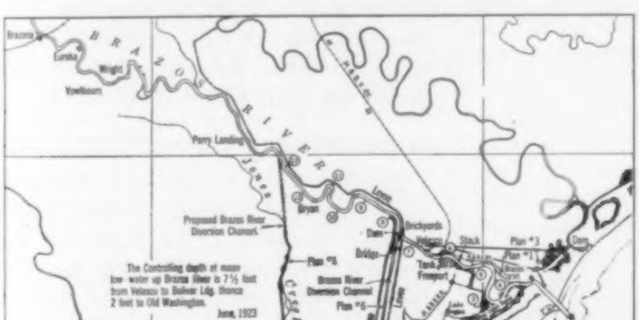


Fig. 2. Hydrographic Chart of the Mouth of the Brazos
Various Proposed Diversion Routes Shown

ft., and on the east bank an existing levee was repaired and strengthened for a like distance.

Two items of the project were not included in the contract and were not taken up until the work previously described was completed. These were the building of a levee on the east bank of the river from just above the diversion up to Buffalo Camp Bayou, and the dredging of the jettied entrance channel and the old river channel just above the entrance to project dimensions. The excavation of the diversion channel and the construction

Highway Bridge Erected on Dry Land
Dredge Excavating Under Draw Span

of the diversion dam and the levees along the diversion channel were done under contract. The contractor used for this purpose one 27-in. hydraulic pipe-line dredge of about 3,000 total horsepower, building both levees and the diversion dam with the excavated material. The work involved the excavation of 7,141,774 cu. yd. of material. Some difficulties were encountered in the construction of the levees, particularly in those sections of the channel where soft alluvial deposits were found. The work was completed in 384 calendar days, at a contract price of 8.15 cents per cubic yard.

### Careful Computations and Studies Made

As planned, the diversion channel was to serve only as a guide channel, dependence being placed on the river to scour it to dimensions adequate to care for floods which might reasonably be expected to occur. The area of the cross section in the diversion channel at the point of diversion and at the Gulf was made practically equal to that of the old river, but for the greater part of the length, the cross section was reduced to about one-third that of the old river.

For calculations as to the capacity of the new channel to carry off flood waters, the flood of 1913, the greatest on record, was assumed as the maximum likely to occur. During this flood the river itself had a maximum calculated discharge at the point of diversion of 80,000 cu. ft. per sec. with a corresponding gage height of 9.8 ft. above mean low Gulf level at the point of diversion. At this time the river was of course out of banks, an unknown amount of water passing to the Gulf over both the east and west banks.

Since a levee was to be constructed on the east bank above the point of diversion, the water previously discharged over the east bank would necessarily have to be taken care of by increased discharge down the diversion channel and over the west bank. It was necessary, therefore, to insure that there was adequate capacity in

the diversion channel and over the west bank to provide for the excess water resulting from the adoption of the proposed plan.

In the computations made, discharges of 50,000, 60,000, 65,000, 70,000, and 80,000 sec-ft. were assumed to be carried by the diversion channel, and backwater curves were computed for these discharges for various dimensions of channel. In these computations Bazin's formula was used in the the following form:

$$V = \frac{157.6}{1 + \frac{m}{\sqrt{r}}} \times \sqrt{rs}$$

with the constant $m$ assumed at 1.5 for discharge in the channel and 4.0 over the berm between channel and levees. The channel was divided into several sections at points where the channel widths and other conditions changed. The computations finally resulted in 70,000 sec-ft. being assumed as the proper amount to be discharged down the diversion channel, the remaining 10,000 ft. spilling over the west bank of the river above the diversion point and flowing across the country to the Gulf. The backwater curve for a discharge of 70,000 sec-ft. was found to reach the diversion point with an elevation of +11.8 ft. above mean low Gulf level.

In order to be on the side of safety, a spillway section of the west bank of the river was considered up to mile 12 only, or about 4 miles above the diversion point, any additional spillway capacity above mile 12 being merely an increased factor of safety. From the water elevation of +11.8 at the diversion point, a water surface in the river upstream was assumed halfway between a horizontal line and a line parallel to the 1913 flood water surface.

### DISCHARGE OVER WEST BANK

The amount of water that would be discharged over the west bank under these conditions was then computed, using Kutter's formula with the value of 0.045 for $n$ for the cleared land in the lower four-fifths of the spillway section, and of 0.08 for timbered land in the upper one-fifth. The computations showed a total discharge of 64,000 sec-ft. over this part of the west bank up to the assumed water surface.

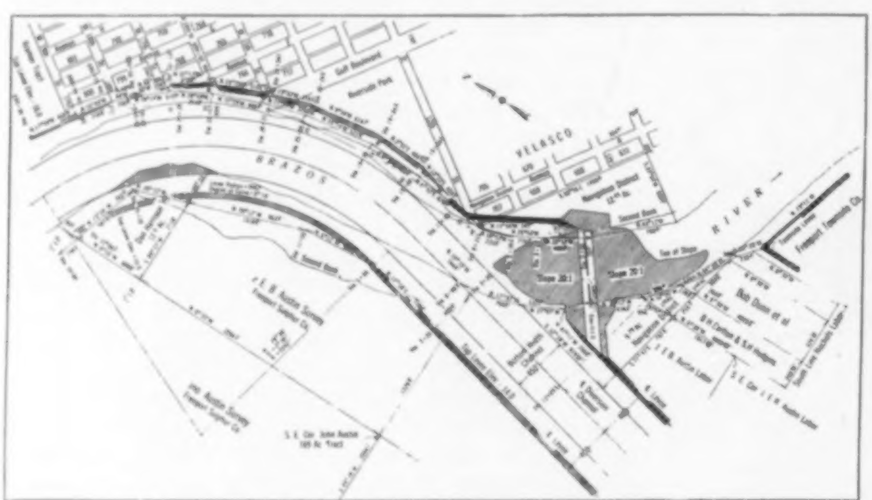

FIG. 3. DETAILS OF DIVERSION DAM SITE
Plans Submitted by Local Interests

Using the same formula, it was computed from the recorded water surface of the 1913 flood, that this flood discharge over the west bank, between the diversion point and mile 12, was about 21,000 sec-ft. This discharge subtracted from 64,000 sec-ft. left a balance of 43,000 sec-ft. capacity to take care of excess water resulting from the leveling off of the east bank and any reduction in the discharge capacity of the diversion channel.

The entire design having been based on the maximum flood discharge of 80,000 sec-ft. passing the diversion point, and 70,000 sec-ft. having been assumed to pass out the diversion channel, there was left a balance of 10,000 sec-ft. to be discharged over the west bank of the Brazos River above the diversion point. Subtracting this amount from the 43,000 sec-ft. left 33,000 sec-ft. to take care of the east bank discharge which would be thrown to the west bank on account of the construction of the east bank levee. It was difficult to compute what actually passed over the east bank above the diversion point in the 1913 flood, since a low levee was in existence at that time, the exact condition of repair of which was not on record.

A study was made of the discharge over the east bank up to mile 12 on the assumption that no levee existed, and this was found to be about 25 per cent less than the discharge of the same flood over the corresponding section of the west bank, or about 15,000 sec-ft. It was therefore safe to conclude that a levee along the east bank could be constructed as planned without throwing to the west bank a greater amount of water than could be discharged safely in addition to the 10,000 sec-ft. previously referred to.

Computations and the construction of a backwater curve from the Gulf shore to the west bank of the river showed that the total amount overflowing the west bank would be safely carried to the Gulf over the open country west of the diversion channel. The main features of this study are shown graphically in Fig. 5.

### FLOOD OF 1929 VERIFIES CALCULATIONS

During 1929, before the diversion was completed, a flood occurred which enabled a check to be made on the amount of water overflowing the west bank in the spillway section used in the foregoing computation. At mile 12, the head of the spillway section, at a stage of 21 ft., it was determined from observations that a total of 137,000 sec-ft. was discharged by the river and over the east and west banks. At a railroad bridge just below the diversion point, a stage of 9.1 was reached, and the river discharge was determined as 63,500 sec-ft. This left 73,800 sec-ft. overflowing the two banks. In passing to the Gulf, the overflow of the east bank must pass through outlets in the Missouri Pacific Railroad fill and could be gaged with a fair degree of accuracy. Observations were made at each of these outlets and the east

bank overflow determined as 29,000 sec-ft., leaving 44,800 sec-ft. to discharge over the west bank. Actual gaging of the west bank discharge was impracticable.

In the computations it had been estimated that the east bank overflow would be about 75 per cent of the west bank. Actual figures showed it to be approximately 70 per cent. For this same flood it was estimated that, had the project been completed, including the levee on the east bank, the diversion would have carried 84,400 sec-ft., leaving approximately 52,900 sec-ft. to spill over the west bank. From this it was decided that 64,000 sec-ft., allowed in the computations to be carried by the west bank, was a conservative figure.

RESULTS OF FLOOD SINCE DIVERSION

Since the completion of the diversion, only one flood of any consequence has occurred. The stage at mile 12 reached +18.75 ft. and at the point of diversion, +9.8 ft. The unusual high stage at the diversion point is attributed in some degree to levees on each side of an old mine-water canal, which crossed the floodway of the diversion at right angles; to the backing up caused by the water entering the restricted section of the channel; and to an unusually high tide prevailing in the Gulf during the period of the flood. Had these old levees not existed, had the narrow section of the channel adjusted itself by scouring, and had tidal conditions been normal, it is believed the gage reading would not have exceeded the estimated normal height of +7.8.

After this flood, practically no change was found in the alignment of the diversion channel, nor in its width. There was, however, a material change in the depths of the channel. From the point of diversion downstream for 4,000 ft. where the width approximates that of the old channel, there was an appreciable shoaling. This is apparently attributable to the decrease in the cross section of the channel near Station 40, resulting in a slackening of current velocity upstream to the point of diversion. From Station 40 to Station 285, near the Gulf, increased depths were found. The increased depths near Station 165 were probably due in part to the soft character of the material in this vicinity, and in part to the small mine-water canal levees extending across the berms of the diversion channel, which largely restricted the flow to the diversion channel proper.

NEW COURSE ENLARGED

While no material increase in width occurred, the fairly uniform increase in depth due to scour is considered an indication that the diversion channel will increase its carrying capacity as was anticipated. It is believed reasonable to assume that the initial increase in capacity will result from an increased depth, due probably to the action of the heavier material carried by the flood currents in eroding the bottom of the channel. It is anticipated that any increased width of channel will be caused principally by the caving-in of the banks due to this increased depth rather than by any direct erosion.

While it is perhaps premature to predict whether any additional dredging of the diversion channel will be required, it appears probable from the results of this one small flood of short duration, that the river will accommodate itself to changed conditions within comparatively few rises, and that artificial enlargement of the new course will not be necessary.

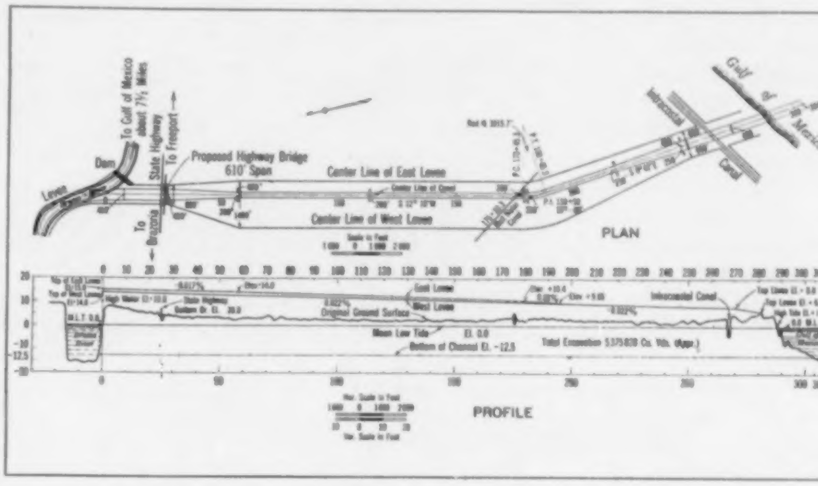


FIG. 4. PLAN AND PROFILE OF THE BRAZOS DIVERSION CHANNEL

A depth of some 6 in. of silt and a considerable amount of drift was deposited by this flood in some sections on the berms of the channel between the levees. The amount of this deposit has, however, been more than compensated for by the increased cross section of the channel itself. While these deposits will probably continue in future rises, it is not believed necessary to take any remedial action at present. In fact, it appears reasonable to think that any deposits along the berms will be completely taken care of by increased scour in the channel.

After this rise, the examination was carried out into the Gulf a sufficient distance to ascertain where the silt from the new river mouth was being deposited. It was evident that, if these deposits occurred too close to the shore line, they might restrict the flow of the river into the Gulf and accordingly decrease the discharge of the new channel. The crest of the bar at the new mouth, however, was found at a distance of about a quarter of a mile from shore, permitting ample room for the water from the river to spread out without any material reduction in the discharge capacity of the diversion channel.

EFFECT OF RIVER SHORTENING NOT YET APPARENT

Prior to the adoption of this plan, consideration was given as to the effect the shortening of the river channel would have, particularly on the course of the river above the point of diversion. From the point of diversion to the Gulf is a distance of about $7^1/_2$ miles by the old river channel, and about 6 miles by the new one, a reduction in length of about 20 per cent.

There has as yet been no indication that the river is endeavoring to regain that $1^1/_2$ miles of its length, but

as the changes in alignment necessary to effect this can be expected only during high water periods, the time since the completion of the new project has been inadequate to offer any indication whether such changes will occur. Accurate maps of the river for a considerable distance above the point of diversion are available, and examinations will be made from time to time to indicate changes of this character, if any.

Another question which would be of interest in connection with this improvement, but which can in all probability not be determined, is the effect that the reduction of the tidal flow at Freeport will have. Prior to this work, tidal influence extended up the Brazos River a distance of 48 miles, and the tidal flow of this section of river was largely concentrated on the jetty and bar channels at Freeport Harbor. This improvement, however, reduced the tidal prism in the river directly tributary to these channels to a length of $7^1/_2$ miles, and in addition created another outlet to the Gulf near enough to the harbor entrance to reduce the tidal flow still further. However, it appears impossible to ascertain what effect this reduced tidal flow will have on channel maintenance.

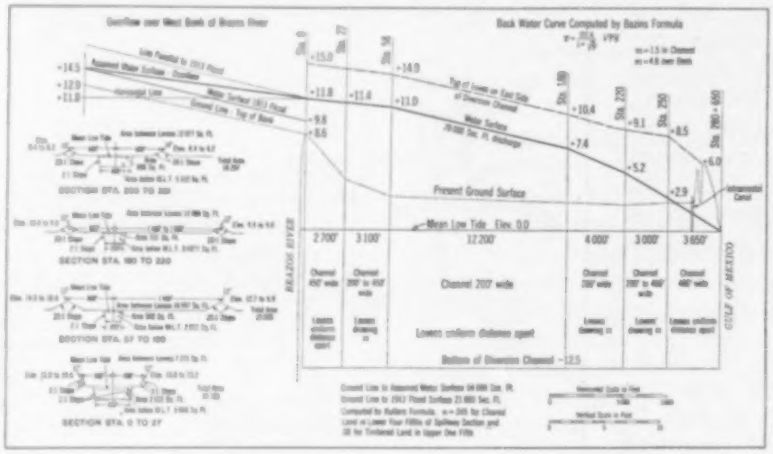

FIG. 5. TYPICAL CROSS SECTIONS OF THE DIVERSION CHANNEL
Plans Submitted by Local Interests

Prior to the diversion, the silting of the harbor due to the river was so heavy and so frequent that no average rate of deposit could be ascertained. While the ascertainment of the effect of this reduction in tidal prism on maintenance would be of interest from an engineerng viewpoint, it is of little practical importance on this project. Prior to the diversion of the river from the harbor, maintenance dredging was necessary after every rise. These rises might occur at any season of the year, and four or five of them a year was not unusual. The reduction in the amount of dredging needed as well as the practicability of predicting when dredging will be required, makes any small amount of shoaling due to a reduced tidal prism of scientific rather than practical value, so far as the maintenance of Freeport Harbor is concerned.

The estimated and actual cost of the various items of the project are as follows:

| | ESTIMATED | ACTUAL |
|---|---|---|
| Diversion channel excavation | $806,374 | $558,947 |
| Levees from Stations 0 to 27 (team work) | 17,700 | 28,000 |
| Dredging in river above entrance to diversion | 30,976 | 29,420 |
| Dam, sheet-pile core wall | 24,000 | 25,600 |
| Highway bridge | 110,000 | 110,000 |
| Road approaches to bridge | 17,110 | 17,110 |
| Drainage ditch west of west levee | 11,700 | 11,700 |
| Levee on east side of river | 76,080 | 63,207 |
| Dredging jetty channel from Gulf to, and including, turning basin | 80,000 | 51,964 |
| Engineering contingencies (channel protection, intracoastal canal protection, and other rectifications) | 408,110 | 2,798 |
| Total | $1,582,050 | $898,736 |

While the item, engineering contingencies, may seem unusually large, it is believed that conditions may develop which may necessitate the expenditure of some of this fund. For instance, the crossing of the Intracoastal Canal may develop as a source of trouble and it may be necessary to take steps for its protection. While it seems unnecessary at present, it may later develop that a lock is necessary in the diversion dam as an opening for navigation above that point. During the last flood, the drainage ditch on the west side of the west levee was filled with silt, and steps are now being taken to clean it out. The navigation district at Freeport has also used a portion of this fund to extend the harbor and deepen it.

The lower 6 miles of the river which has been cut off by the dam is now a tidal basin, the lower part of which is at present being utilized as a harbor and the remainder is available for that purpose. The width of this basin is approximately 450 ft.; that portion used for a harbor channel is 25 ft. deep, and the remainder is 9 ft. Thus a harbor has been created, free from strong currents and wave action, which is capable of accommodating sea-going vessels and which, it is believed, will need very little maintenance dredging except at the outer end of the jetty channel where there is some littoral drift in the Gulf.

With the current reduced from a maximum of 8 to 10 miles per hour to a maximum of from 1 to 2, a channel and harbor have been provided in which ships of all classes may easily and safely maneuver at all times, a condition which did not previously exist during floods. Another benefit derived by the harbor is the removal of the drift menace. During times of extreme floods considerable drift, some of which consisted of trees 3 to 4 ft. in diameter and nearly 100 ft. long, were carried by the swift current and became a serious hazard to ships, wharves, and other structures along the waterfront.

As to the reduction in the cost of maintenance of the harbor, exact figures as to the saving effected are not yet available since the diversion has been in operation for only about one year. At the time the water was diverted, the harbor did not extend out to the official harbor lines. Additional depth and length having been authorized, this work was combined as much as possible with cleaning out the channel to the original project dimensions. What figures I have, however, tend to show that economically the project is sound. During the years 1926, 1927, 1928, and 1929, an average of $87,000 per year was expended on maintenance. From the time the diversion was completed, a total of approximately $37,800 has been expended on maintenance, indicating, aside from all other benefits derived, an annual saving of approximately $50,000.

# Prequalification Eliminates Unfit Contractors

PRINCIPAL OBJECTIONS MET AND PRACTICAL ADVANTAGES DISCUSSED

*THE present age of expansion in construction is particularly interested in plans for increasing efficiency and decreasing costs in all building projects. Prequalification of contractors, with its promise of eliminating the unfit, is coming more and more into general favor. Examining the reliability, responsibility, and capability of a contractor before he is allowed to enter his bid relieves the public official of the responsibility of rejecting a low bid and the contractor of the consequent embarrassment of having his bid rejected. Mr. Brooks here presents an interesting survey of the prequalification situation and its legal status. Mr. Parrish's paper advances numerous arguments in favor of prequalification, while Mr. Christie relates its history and describes its effect on stamping out unscrupulous practices in the construction industry. Mr. Zass reviews the principles governing prequalification. These articles are abstracts of papers presented before the Highway Division of the Society at the St. Louis Convention in October 1930.*

# Present Status of Prequalification

*By* ROBERT B. BROOKS

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PREQUALIFICATION of contractors, so far as this paper is concerned, will be taken to mean the ascertainment of competency of prospective bidders before a letting. Is this prequalification desirable and, if so, is it feasible under existing political conditions?

A study of contracts executed all over the United States reveals a great number of disastrous failures. These failures on the part of incompetent and defaulting contractors have cost the public untold millions of dollars and foisted upon it cheap materials and slipshod work, to say nothing of the monetary loss to the contractors and their disgruntled guarantors. It is generally understood that a contract on public work shall be given to the lowest responsible bidder. The problem for the past several years has been how to protect the public from the wiles of the irresponsible bidder. A contractor may be irresponsible in bidding on a given contract because of lack of financial resources, equipment, organization, and sufficient experience in that special kind of work.

A large surety company has, through its executive officer, classified the costs of losses sustained by it as follows:

| | |
|---|---|
| Inadequate financial responsibility and over extensions | 50 per cent |
| Incompetency | 25 per cent |
| Miscellaneous reasons, such as hard luck and difficult situations | 15 per cent |

THE PUBLIC PAYS

Where irresponsible contractors default on work, the public also pays heavily in time lost. For example, suppose that a sewer is to be built along an arterial highway in 90 days—the time specified so that the pavement may be laid before winter weather sets in. A contractor with inadequate experience and capital starts to work, but cannot complete his contract until 30 days after the specified time, which is too late in the season to complete the street. All traffic would be inconvenienced throughout the winter on this account; and even though the contractor might be able to pay in liquidated damages $100 to $200 per day for the extra 30 days, this would not compensate the public for not being able to have a usable street during the winter.

So, to protect the public and the construction industry, there has arisen out of the chaotic conditions resulting from bidding on public work, a proposed remedy—that of prequalification of contractors.

ARGUMENTS FOR AND AGAINST

P. M. Tebbs, M. Am. Soc. C.E., Assistant Chief Engineer of Pennsylvania, has ably summed up the arguments for and against the prequalification of bidders. Proponents of the prequalification of contractors argue that the adoption of the system would: (1) improve quality of competition but not limit it; (2) stabilize contractors, preventing unwarranted expansion; (3) eliminate political influence and favoritism; (4) insure completion of contracts on schedule, thereby lessening the length of time that detour or half-width construction would be in operation; (5) eliminate the type of contractor who peddles low bids in order to obtain the assistance of bankers and material representatives in financing his proposed undertaking; and (6) eliminate improperly qualified engineers, superintendents, and foremen.

Arguments against inauguration of the system are that it would: (1) place unlimited authority in the hands of a commission or board of individuals; (2) limit competition, thus causing higher prices for work; and (3) encourage political and other influences in behalf of contractors who have been disqualified.

Prequalification of contractors on public works is now a law in California, Georgia, Iowa, Missouri, Tennessee, Wisconsin, and South Carolina. The U.S. Bureau of Public Roads has been using prequalification for all of its work, and Thomas H. MacDonald, Director of the bureau, stated before the Associated General Contractors' spring board meeting that the number of defaults on its work had been lessened from six in 1926, the year immediately preceding the adoption of the prequalification policy, to one each in 1928 and 1929.

#### ENDORSEMENT FROM USERS

The prequalification law in California became effective in August 1929, and was immediately put into operation by the Public Works Department, which now has in its confidential files records of the skill, integrity, and responsibility of general contractors, including information concerning their experience, the personnel of their organizations, and their financial ability to carry on construction, the latter classification containing ratings as to the size of jobs they may, in the opinion of the department, undertake.

*PREQUALIFICATION is but an extension of the principle applied to the professions, where the possession of theory and practice must be demonstrated by the applicant and attested by diploma and State board; and in the trades, where those who would be masters must serve apprenticeships.—Philadelphia Bureau of Municipal Research, April 23, 1929.*

The Secretary of the Association of State Highway Engineers states that a letter ballot of its members was unanimous in favor of the adoption of prequalification in State highway work throughout the country.

Some time ago the Bureau of Public Roads began making time studies to determine the costs of unsatisfactory progress on Federal Aid road projects. The cost of delays and their representative proportion of the total is as follows:

| | |
|---|---|
| Poor management | 52.7 per cent |
| Weather | 26.4 per cent |
| Inadequate equipment | 8.2 per cent |
| Construction difficulties | 6.0 per cent |
| Cause not stated | 2.6 per cent |
| Material delays | 1.2 per cent |
| Financial delays | 1.1 per cent |
| Legal delays | 1.0 per cent |
| Labor shortage | 0.5 per cent |
| Preliminary difficulties | 0.3 per cent |
| Total | 100.0 per cent |

Opponents of prequalification of contractors argue against having the confidential, sworn statements of contractors brought into court and thus aired before the general public. However, when attorneys demanded access to records relating to the Forest Park section of the River des Pères branch work in St. Louis, they were refused permission to examine these documents by the Board of Public Service.

The City Counsellor's advice in the matter was to the effect that neither the charter of St. Louis nor the statutes of Missouri contained provision for the inspection or use of such records by the general public and that the officer in charge had the privilege of denying such inspection. The opinion commented also on the soundness of this policy and stated that no court would attempt to substitute its judgment for that exercised by the board.

In the interest of fair competition, both to the contractor and to the public, it seems reasonable to require prospective bidders to have their responsibility passed on before bids are opened; and it enables public officials to use their own judgment without the embarrassment of knowing who the low bidder is.

Prequalification of contractors will not, of course, put an end to all of the evils of the construction industry. It will, however, remove much of the trouble of the business by applying the remedy before a concern is allowed to bid.

#### PREQUALIFICATION RESULTS

Highway officials of 11 Western States, at the Annual Convention of Highway Officials at Boise, Idaho, July 9 and 10, 1930, expressed themselves in favor of prequalification. Among those who spoke were C. H. Purcell, Assoc. M. Am. Soc. C.E., State Highway Engineer of California, and Dr. L. I. Hewes, M. Am. Soc. C.E., Deputy Chief Engineer of the Bureau of Public Roads. The former stressed the fact that, under the old system, the incompetent must be eliminated after bids were received, which made it very difficult to convince either the contractors or the public of the wisdom of awarding the contract at a higher figure than the lowest submitted. And Dr. Hewes stated that, since adopting prequalification, the bureau had had to disqualify only three out of 100 bidders.

In a recent address before the Association of Highway Officials of the North Atlantic States, Henry H. Wilson, M. Am. Soc. C.E., Vice-President of the Associated General Contractors, called attention to the fact that, under the postqualification system, bidders are enabled through competition between bonding houses to qualify after bids are in. He also stated that the contractors themselves favor prequalification because, without it, they are forced to compete with inexperienced men whose underestimating frequently leads to default, with gamblers who bid low and hope for lucky breaks, and with bidders who hope to make up for low bids by inferior workmanship.

Further endorsements of prequalification have been received from H. K. Bishop, M. Am. Soc. C.E., Chief of the Division, Bureau of Public Roads, who cited the bureau's three years of favorable experience with the system, and from district engineers in the Highway Departments of South Dakota, Georgia, Iowa, Tennessee, Kansas, California, and Wisconsin. The report of the latter indicated that prequalification has resulted in an improved quality of work, more cooperation from contractors, abler and more economical management, reduction of engineering costs and overhead, and increased production.

The State of Iowa reported that it had employed prequalification since 1927 and would continue the practice, while Wisconsin stated that the system had been in effect since 1925, not by statute but by ruling of the State Highway Department. In the latter State it was found that 50 per cent of the contractors were behind schedule time before prequalification and only 10 per cent after prequalification, and that the system resulted in a highly improved quality of work.

The Bureau of Municipal Research of Philadelphia succinctly sets forth the advantages of prequalification as follows:

"Prequalification permits the establishment of lists of competent bidders when there is ample time for consideration and investigation of the contractors' claims. It saves the unqualified contractor the time and money spent in making a bid, and the publicity and embarrassment of a rejection if his bid should be the lowest. When all the bidders are qualified, the public official who awards the contract simply awards it to the lowest bidder. He is saved the exercise of his discretion at a time of stress, and avoids the public suspicion and criticism which often follow the rejection of a low bid on grounds of the irresponsibility of the bidder. Advocates of prequalification also claim that when there is assurance that none but qualified bidders will be considered, qualified bidders will enter the competition in greater numbers."

### IS PREQUALIFICATION CONSTITUTIONAL?

Granted, then, that prequalification of contractors is desirable and that it has been tried successfully, over a period of time, by the U.S. Bureau of Public Works and the States of California, Georgia, Iowa, Missouri, Tennessee, Wisconsin, and South Carolina, it remains to be seen if it is constitutional. It is generally true that the policies which are in the best interests of the public are found by our courts to be constitutional.

The city of Philadelphia has, however, taken the lead among large cities to determine the constitutionality of prequalification by passing an ordinance, approved as of June 14, 1929, legalizing the prequalification of contractors. This ordinance, which was recommended by the mayor's City Contract Committee, suggested the use of a form of questionnaire for collecting comparable information on the equipment, experience, and financial condition of contractors. It provided that the director should analyze the questionnaires and make up a list of qualified contractors. It also made provision for an appeal board consisting of the Letting Director and two other city officials, conversant with construction details, to be appointed by the mayor. The rejected applicant could appeal to this board, which could qualify an applicant disqualified by the director but could not disqualify those whom he had qualified.

An applicant who had been disqualified by both the director and the Appeal Board carried his case to the courts, and the Supreme Court held the ordinance invalid because it did not approve of the method of deciding who was responsible and who was not. The court did, however, confirm the city's right to prequalify contractors—that is, it decided that the city had a right to decide that the contractors whom it deemed irresponsible would not be permitted to bid. The single point to which it objected was the provision that when an appeal was made from the decision of the awarding officer to the board of three judges, the board was not allowed to review the questionnaires submitted by the other bidders on the same project for purposes of consideration or comparison, nor could it remove from the list of qualified bidders any names which the awarding official had placed on it.

On July 2, the City Council of Philadelphia immediately passed a new prequalification ordinance, which became effective September 5, 1930. This ordinance was written to include the provisions which the Supreme Court of Pennsylvania had held to be essential when it declared the first prequalification ordinance unconstitutional. According to the new ordinance, the Letting Director will first make up the qualified list, but any bidder, whether rejected or accepted, may appeal to a board composed of the director and two city officials appointed by the mayor. On appeal, this board determines the qualifications of all applicants. It can accept those rejected by the director or reject those accepted by him, thus making the list of qualified contractors the work of the board and not of the director. It is believed that this new ordinance will satisfactorily meet the objection made by the Supreme Court of Pennsylvania.

That the proof of the pudding is in the eating is evidenced by the fact that, in those sections of the United States where the prequalification system is in effect, irresponsible contractors have gradually been weeded out and better results secured in construction work, and in no case have responsible officials wanted to go back to postqualification methods. In fact, the high cost of incompetency, the improved quality of the work, modern engineering practice, and progressive legislation in the several States form a body of public opinion overwhelmingly in favor of the prequalification of contractors.

# Practical Applications of the System

*By* ALAN JAY PARRISH
GENERAL CONTRACTOR, PARIS, ILL.

PREQUALIFICATION is, in its broadest sense, the determination of an applicant's qualification for a given responsibility before intrusting him with that responsibility. Applied to construction, it is the determination of a contractor's competency and responsibility to satisfactorily complete a given construction project before he is allowed to submit a bid. On the better class of private work, bidders have generally been prequalified. Many of the most prominent engineers and architects who value their reputations insist that bids be invited only from a selected list of responsible contractors. Public utilities, such as railroads, also receive bids only from those whom they have found to be competent.

It is, however, only within recent years that prequalification has come into use on public works. The most

outstanding example on Federal Government operations is its use by the U.S. Bureau of Public Roads, where it has been applied for nearly four years.

Thomas H. MacDonald, Chief of the Bureau, states that the experience of the bureau in the prequalification of bidders for forest and park road contracts has been very satisfactory. And, in a more recent statement, Mr. McDonald calls attention to the fact that the public must be made to realize that prequalification is not an intrigue which stifles competition, for the only competition that can be helpful to the public is that existing between efficient agencies.

### STATE HIGHWAY WORK

The American Association of State Highway Officials recently submitted a "Yes" and "No" ballot concerning prequalification to the various State highway departments. This resulted in an overwhelming number of votes in favor of the principle of prequalification, only two of the States voting "No."

This indicates the trend of sentiment in State highway departments throughout the country. Both the California and South Carolina laws were applied to State highway work on the 1930 programs. However, most of the State highway departments prequalifying bidders base their authority not on the enactment of a specific statute on this subject, but on the broad powers granted them under the law to select "the lowest responsible bidder." After commenting on the fact that prequalification does extend beyond its specific requirement by statute and that numerous municipalities and the Federal Bureau of Public Roads have adopted it, a recent issue of the *Engineering News-Record* editorially remarks: "Encouragement and understanding of prequalification are still largely lacking among engineers. Their association work, except the recent action of the Association of State Highway Officials, does not evidence even academic interest. It has been the contractors' associations so far that have had to wage the battle for predetermined competency of bidders and to carry conviction of its importance into engineers' associations."

*LEGISLATIVE action represents only a fraction of the advance. If the adoption of prequalification did not extend well beyond its specific requirement by statute, the situation would indeed be discouraging. As actual fact, half a dozen States, without definite law, require prequalification, numerous municipalities have adopted it, and the Federal Bureau of Public Roads employs it on all contracts awarded directly by the bureau. A canvass of these engineers shows unanimous agreement that it has decreased defaults and increased the percentage of work completed on time, and has encouraged competition of the desired kind.—Editorial, Engineering News-Record, July 10, 1930.*

In recognition of the fact that the lowest bid is not always the best bid, statutes generally provide that contracts shall be given to the lowest responsible bidder. Awarding officials have always been given discretionary power in the award of contracts, but they have not always used it.

In fact, a study of the history of contract awards made over a long period reveals that this discretionary power was formerly used in a much broader way than it is today. Little by little, over a period of years, officials have been curtailed in its use. One of the reasons has been the increasing efficiency in modern industry due to new inventions and better systems of management which have led to increased production and, many times, to over-production, the latter having given rise to high-pressure selling. This spread to the construction industry, encouraging loose credit practices and the setting-up of many contractors who were neither experienced nor competent.

### PRESENT-DAY NEEDS ARE GREAT

A report from the Philadelphia Bureau of Municipal Research emphasizes the fact that, because present-day construction work is on a greater scale than ever before and consequently requires more time and capital and better management, the contractor must be more than a constructor. He must know about markets and buying, mechanical equipment, organization, management, and cost keeping.

Too often the contractor is not a man of this ability. And as a "cure all" for resulting conditions, the construction contract bond has come into general use. Awarding officials have all too readily believed that ability to give bond is an evidence of responsibility. As a matter of fact, however, the same strong competition existing in other lines has spread to the field of marketing surety bonds; and surety agents, dependent on commissions for their income, have found that it does not pay to be too particular about their customers. The discretionary responsibility, which public officials so frequently pass on to the surety companies, has been largely ignored and the contract generally awarded to the low bidder, as any low bidder can get a surety bond from one company or another.

The results of this are sad, for if the contractor is honest, he loses his money, and is forced out of the competition; whereas, if he is dishonest, he slights the job at the expense of the public, neglects to pay his bills, and then moves into another locality where he repeats the same performance. The surety bond provides no protection against the losses which grow out of defaulted or unsatisfactorily performed contracts. It merely guarantees that, barring some chance of escape on technicalities, the project will somehow be completed and a considerable proportion of any direct financial loss will be made good.

In theory, it may seem that the only remedy for such conditions is the qualification of bidders; but to apply that remedy has been proved difficult. In 1924 and 1925, however, the Joint Conference on Construction Practices published its "Standard Questionnaires and Financial Statements" for use in qualifying bidders. These questionnaires now have a wide use and have been officially approved by the American Association of State Highway Officials. In spite of the success of this method, however, it has been found that a proper investigation of bidders usually requires more time than can be given after bids are opened.

### ADVANTAGES OF PREQUALIFICATION

So the necessity for prequalification seems increasingly obvious, and I shall list here several points in its favor:

1. It relieves the awarding authority of the criticism entailed under postqualification by rejecting the low bid of an irresponsible or incompetent contractor.

2. The awarding authority has adequate time to investigate the contractor's past record, including performance, payment of bills, equipment valuation and ownership, and volume of uncompleted work.

3. It encourages a better class of bidders without limiting competition.

4. It prevents unwarranted expansion on the part of contractors and consequent default and loss to the public.

5. The expense of field investigation and estimating is saved the bidder who cannot qualify for a particular project.

6. Rejection is less embarrassing to the contractor.

7. A curb is put on the wholesale supplying of bid bonds and certified checks.

8. The banker is relieved of his anxiety.

In a paper read before the American Society for Municipal Improvements, W. L. Collins compared the prequalification of contractors with the licensing or registration of professional men, on the grounds that it eliminates them from constant competition with men without pride in their profession. This is particularly the case in public construction work which is, at present, overrun by individuals who have not the qualifications to enter the private field.

*PRACTICALLY any contractor, whatever his financial standing; whatever his experience or lack of experience; whatever his equipment, sufficient or insufficient; whatever the relation of his liquid assets to the amount of work he has on hand; whatever the extent to which he has become overextended; can obtain a bond. Some surety company will execute bond for him, and he goes from one company to another until he gets what he wants. The irresponsible contractor can usually find some company to go surety for him. This is the result of competition.—Report of Joint Conference on Construction Practices, September 1924.*

## OBJECTIONS MET

In a bulletin entitled *Objections to Prequalifying Contractors Considered*, the Philadelphia Bureau of Municipal Research answers the objection that the questionnaires are too complicated with the statement that, while many smaller contractors have incomplete and perfunctory records that discourage an attempt to respond accurately to a definite set of questions, responsible members in any commercial field should keep books—for their clients' safety, if not for their own. So if the questionnaires did no more than promote the general use of proper accounting methods among contractors they would still be worth while.

Nor is it true that an undue expenditure of time and labor would be involved in filling out the questionnaires, for it is not necessary that a full set of questionnaires accompany each bid. In fact, one experience questionnaire a year, submitted when the lists of qualified bidders are being compiled, should be sufficient. The financial questionnaires should be required only twice or, at most, four times a year from those on the eligible lists. Each bid, of course, should be accompanied by an equipment schedule for the job in question and a current financial statement.

The bulletin also answers the argument that prequalification would restrict the construction field to large and rich concerns by stating that practically all contractors begin in a humble capacity with some already responsible organization; and, under prequalification, such men would be welcomed in the lower classifications, advancement depending entirely upon merit. In face of the objection that the questionnaires invade private affairs, the bureau points out that only under exceptional circumstances would the information be accessible to others than the officials required to pass upon it.

Prequalification would, as stated in the bulletin, minimize the danger of political "abuses" on the part of officials, and it would also combat favoritism.

## LEGAL ASPECTS OF PREQUALIFICATION

Until recently the legal status of prequalification was very uncertain. No case involving it had ever come up in court, and its advocates were anxious when, in 1929, a contest was started in the lower courts of Philadelphia County, Pennsylvania, against a Philadelphia city ordinance providing for prequalification.

After a favorable decision rendered by the Common Pleas Court, the case was then taken to the Supreme Court of Pennsylvania for the Eastern District, which finally handed down a decision declaring the ordinance in question invalid due to the faulty method of applying the principle. At the same time, it sanctioned the right to enact a prequalification ordinance, and the city council soon acted on the prerogative.

## NECESSITY FOR DISCRETION

It is obvious that discretion must be used in the administration of prequalification. For instance, the office of the U.S. Supervising Architect, in a conscientious effort to prequalify bidders on a large Government building project, declared that no one who had not previously built a similar structure costing at least $500,000 should be permitted to bid. The U.S. Comptroller General declared this requirement arbitrary and refused to approve a letting under such a rule, as a contractor who had had wide experience, but not in his own name, would thus be excluded from bidding.

Extreme care must also be exercised in formulating numerous requirements as to liquid assets, equipment, and the like. It would seem to be unwise to try to write into any proposed prequalification law, or any set of rules and regulations governing its application, anything calculated to take the place of individual discretion.

A contractor's liquid assets should bear some relation to the volume of work undertaken. But no universal rule can be worked out for such a ratio, because the maximum amount of work a contractor can safely undertake with a given amount of liquid assets depends upon several factors, not the least of which are his own business ability and the character of the work. It is certain, however, that when the ratio is too high, the contractor cannot meet his financial obligations promptly and is liable to default.

## BUREAU OF CONTRACT INFORMATION

In any attempt to verify the statements of the bidders as to their qualifications, there is one particular difficulty,

which is that, even when statements are submitted under oath, some bidders will not only falsify but will also try to hide or cover up some part of their record. When the awarding authority attempts to check up, he often finds there is no reliable source of information that will enable him to make a check. So, for a number of years, the far-sighted in the construction field have realized the need for a better credit structure in the industry and, specifically, for a central clearing house of information on contractors' past performances and contracts on hand. Therefore, the Bureau of Contract Information, Inc., with offices in Washington, D.C., was inaugurated in August 1929. The bureau is now well started on the huge task of compiling files concerning thousands of contracting concerns throughout the country. It has already made its influence felt by promoting better bonding practices, by curbing over-extension by contractors, and by upholding the responsible elements in construction.

### The Need for Cooperation

Prequalification is a step forward. It is a measure, as the court declared in the Philadelphia ordinance case, "whose design and effect will be to substitute the scientific for a haphazard method of determining the lowest responsible bidders." But it is not claimed here that it is a panacea for all the ills which beset the construction industry. Cooperation of all elements in the construction field is necessary to promote or even maintain fair practices. The engineer cannot stand alone in the matter of awarding contracts. He needs the support of surety companies who will refuse to bond everyone, of material and equipment interests, who will band together to eliminate loose credit practices, but, above all, he needs the cooperation of the responsible element among contractors.

# Protection Against Unscrupulous Practices

*By* Ward P. Christie
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The history of prequalification dates back to 1924. At that time, a committee of the Associated General Contractors of America and the American Association of State Highway Officials, in session in Detroit, conceived the idea of qualifying contractors before bids are received.

Perhaps it will be useful to explain the difference between qualifying before bids are received and qualifying after. One might think that a good investigation would, in either case, produce the same results. In reality, however, if bids are once opened, facts are often so rearranged and distorted that the most careful official investigation will not reveal the truth.

### Agents Defend Low Bidders

Once a low bidder is identified, many agencies attempt to defeat an investigation. In fact, the mere opening of proposals makes an almost miraculous change in the standing of the low bidder. He may be without experience or anything else, but a scramble for his business begins. He becomes of immediate value to surety companies, liability insurance companies, equipment concerns, material dealers, and various other organizations. He becomes identified with a great deal of money. So even bankers have an interest in him, although he may be reaching beyond the proper facilities of bankers.

As a matter of fact, I should not be surprised if 30 per cent of the members of the contracting business were absolutely bankrupt. Yet I have been informed by highway officials that bankers often testify as to the responsibility of contractors, even when the contractors owe them large sums of money. In such instances, they are taking new risks to see if they can get some of their money back, and it is impossible to make them tell the truth concerning the contractors.

### Tricks of the Trade

Often the low bidder, who has no money, will find a banker willing to place 10 per cent of the contract amount to his account. The contractor cannot use this money, but it enables him to face the investigation of the qualifying committee when the bids are opened. After the bidder has been found to be responsible and is awarded the contract, the money is immediately taken from his account.

In the case of equipment, much the same situation occurs. Before investigation, the contractor may not have any equipment. After he becomes identified as the low bidder, however, he finds himself in possession of steam shovels and other equipment for which he has not made a cent of down payment. The contractor may use this same equipment for collateral to the banker. But after the job is under way the equipment company may get tired of waiting for its money and take the equipment off the job.

When the dealer, to whom the contractor is in debt, is approached, he generally says that the contractor owes him no money; and even an investigation will not necessarily reveal the truth, as the contractor may have given the dealer a note and left the note out of the financial statement.

If the contractor has had no experience, he will sometimes employ a superintendent who is experienced and thus qualify on that score. As soon, however, as the contract has been awarded and the work is under way, the contractor is apt to remove this superintendent from the job and substitute a cheaper one.

### Situation Must Be Met

Such practices as these have flourished in the past because of the lack of organization among contractors

and the other agencies concerned. There is room, then, for organization within the ranks and for close association between contractors and engineers, as their interests are almost identical. Even now, in some localities, so much has been done in the right direction that officials no longer feel obliged to award contracts to the lowest bidder. New contractors' organizations tend to disclose the truth and to support officials in their awards.

The machinery of prequalification, or of any intelligent investigation, seems perhaps a stumbling block. Without prequalification, there has been no credit structure to the construction industry, no exchange of credit information. Contractors have been able to change their corporate names and let the bills stack up behind them. Since many of them do not even intend to pay their bills, they do not find it necessary to bid for a profit. In fact, I have known contractors to deliberately bid below cost, let their indebtedness accumulate, then let their corporation go into bankruptcy.

### STEPS IN THE RIGHT DIRECTION

Fortunately, contractors and surety concerns are cooperating more than was formerly the case, and a real constructive effort has been made to discover the truth about contractors. The sureties largely contribute the finances; they and the contractors have an independent bureau, the purpose of which is to establish a service record for every contractor in the United States. The first step has been to request the voluntary submission of service records, and to date I think that about 3,500 of these have been received and are being verified.

Supplementary to this, local bureaus of credit are being formed throughout the country. Such bureaus are inter-industry affairs, with independent auditing departments of their own. They compile the delinquent accounts for every one connected with the industry, and once a month issue a delinquent list which shows whether a contractor is paying his bills. There has as yet been no national link-up of these bureaus, but there ultimately will be.

### INTER-GROUP COOPERATION

It will require inter-group cooperation to clean up the construction industry, for cooperation within our own trade group is not enough. I believe that all construction groups are interrelated, and I doubt if contractors or engineers can even achieve the prestige that they would like to have by proceeding individually. These two agencies have been aloof too long, and the unfavorable conditions in the construction industry of which I have spoken are, I think, largely the result of lack of contact between them.

Prequalification should be on the official programs of the major associations, and I wonder if it might not be advisable to revive the old conference on construction practices which produced the questionnaires. Weight has been given these questionnaires by reason of the fact that the conference was composed of committees from all the associations. The new conference questionnaires are now being considered by the Inter-department Board of Contracts of the Federal Government for use in all departments. This same board is investigating the probabilities or possibilities of establishing prequalification. It is doubtless only a question of time until the use of questionnaires and prequalification will be adopted by the Federal Government.

It may be a good idea to proceed as before and establish a connection with the Department of Commerce. If that is done, it will be possible to develop a comprehensive analysis and have it issued as a document by the U.S. Government, and this will be very valuable in promoting prequalification.

# Qualification Principles Reviewed

By W. W. Zass

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In attempting to formulate policies and procedures for the control of competitive bidding on construction projects, it occurs to me that we are endeavoring to correct, through superficial measures, basic faults in the system. I introduce this thought only to suggest that the promulgation of more rigid requirements in competitive bidding will not entirely eliminate the failures or imperfections now apparent in the system.

An analysis of the subject indicates that three general methods of procedure govern the awarding of contracts upon a competitive bidding basis. These, named in the sequence in which they probably developed, are non-qualification, postqualification, and prequalification.

### GROUPING OF CONSTRUCTION ACTIVITIES

Construction activities can generally be primarily subdivided, through reasons of ownership, into two major classifications: the public, and the non-public works groups. The first consists of city, county, State, and Federal agencies, and is controlled by statute in the procedure relative to the advertisement of work and the award of contracts. The second group, consisting of corporations, companies, and individuals, is free of such restrictions. Legislative requirements generally provide that the work shall be advertised and that the contract shall be awarded to the lowest bidder or to the lowest responsible bidder.

In theory, the comparative advantages or disadvantages of the principles of the three methods of qualifying apply with equal weight throughout the entire field of the construction industry. In practice, however, the advantages or disadvantages of such principles are minimized or magnified by conflict with existing legislative enactments or with local prejudice or disfavor. Any general analysis of the principles must, therefore, be

based on local conditions that affect the practical application.

SURVEY OF NON-QUALIFICATION

The advantages and disadvantages of non-qualification may be stated in brief. One disadvantage is that the principle of the system does not allow the owner any choice in the selection of the constructor, thus increasing his difficulty in obtaining work of the first quality. Other objections are that administration may become involved, that the working period may be unduly prolonged, and costs unnecessarily increased, that surety bonds do not wholly guarantee satisfaction either during the progress of the work or at its completion if an incompetent contractor is the recipient of the contract award, and that undesirable competition is stimulated.

Conversely, it might be stated that the principle of non-qualification provides for competition without administrative restriction or prejudice, and that through such unlimited competition a lower construction cost level may be maintained. It might also be argued that initiative is encouraged and that the ability to provide a proposal guarantee and contract bond is sufficient indication of responsibility, the percentage of defaults among bonded contractors being in the minority as is evidenced by the bond premiums in force.

*A DISHONEST contractor may impose work upon the city—in spite of the utmost caution of the superintending engineer—apparently good and even capable of bearing its duty for a time, which in the end may prove to be a total failure and worse than useless. Granted, that from such a contractor pecuniary damages may be recovered by an action at law; this is, at best, but a last resort, that often produces more vexation than profit—a mere patch upon a bad job. . . . The City requires honest work, not law suits.—Justice Gordon, Supreme Court of Pennsylvania.*

POSTQUALIFICATION CONSIDERED

Arguments in favor of the principle of postqualification are that it allows the owner to exercise some judgment and discretion in the selection of the constructor, consequently decreasing his difficulty in obtaining work of the first quality, and that other annoyances, delays, and losses incident to the operations of an incompetent contractor are eliminated. It might also be stated that it would decrease defaulting of contracts and eliminate undesirable competition in bidding, the ability to submit a proposal guarantee and execute a surety bond not being a sufficient indication of responsibility.

Those who object to the principle of postqualification might do so on the grounds that the system, if improperly administered, restricts competition through partiality and favoritism, and that it is not equitable to disregard a proposal after the contractor has been allowed to place it, as the ability to secure a proposal guarantee and execute a surety bond ought to be sufficient indication of responsibility.

THE PREQUALIFYING METHOD

Proponents of the principle of prequalification feel that it provides for all of the advantages of postqualification and eliminates many of the disadvantages, besides helping the bidder, who wastes neither time nor expense in placing proposals that will not be considered. It might also be pointed out that, in the non-public works group, the practice of prequalification of bidders has existed for years with excellent results.

On the other hand, it could be claimed that prequalification, by its method of limited competition, raises the construction cost level and admits of the formation of preferred associations or groups of contractors, which might control the bid prices submitted.

The term "responsible," as applied to a contractor, indicates the possession of initiative, experience, organization, equipment, and money in sufficient measure to start and complete the work in question. It must be realized that those interested in obtaining construction work on a competitive basis are faced with the necessity of quoting a price on the work sufficiently high to ensure a profit while, on the other hand, the price quoted must be sufficiently low to enable them to underbid their competitor. In order to obtain this medium, close figuring or estimating is necessary, and even then the job may go to a competitor who guessed at, rather than estimated, his costs. If a responsible party bids against another responsible party, healthy competition is ensured, as a legitimate margin of profit is not eliminated by such competition, and lower production costs in the execution of the work are ensured through different and more efficient methods of operation.

THE CONTRACTOR'S NEED

We find, however, that the construction world does not consist wholly of responsible individuals or organizations, but that it also has a fair share of the dishonest, the incompetent, and the inexperienced. With these classes the responsible contractor is placed in competition, and from these classes he requests protection. In endeavoring to place the construction industry upon a higher plane, the responsible constructor seeks qualification and, in order to qualify on a recognized basis, he asks for qualification prior to the receipt of the proposals. So the position the legitimate contractor contends for is not unreasonable, being analogous to the recognition of professions and the qualifying of artisans.

Reviewing the situation from the owner's viewpoint, one may well question whether the qualifications of bidders cannot be as thoroughly analyzed following the receipt of proposals as before it. It is true that, if the same impartial judgment is exercised in weighing the various considerations involved, no differences in the results should be expected; and political influences or the influences of other outside agencies would tend to make qualification difficult under either system practiced. So the prequalification of bidders is not necessarily always of benefit to the owner, who exercises discretionary powers in selecting other than the low bidder. The prequalification of bidders, therefore, seems primarily a protective measure for the legitimate and responsible contractor. In all justice to him and in furtherance of the construction industry in general, the owner would also do well to adopt the practice of prequalification. Moreover, under the prequalification system all applicants should be graded or rated, according to the type as well as the extent of the work for which they may so qualify.

# Foundation Problems and Their Solution

FIVE EXPERTS FEATURE THE APPLICATION OF VARIOUS METHODS

*FOUNDATION design and construction should be subject to as exacting an analysis as are superimposed structures, and they are as worthy of study. The problems of the foundation engineer are inseparably connected with those of the structural engineer. The choice between the available types of foundations—spread footings, mats, piling, or caissons—depends on a vast number of factors such as depth to bedrock, bearing power of overlying soils, friction on piles and caissons, allowable settlement, if any, and the comparative cost of each combination. It is the problem of the foundation engineer to select that type which will most efficiently perform the service required for the least cost. This foundation symposium, abstracted from a group of papers presented before the Construction Division of the Society at the St. Louis Meeting, October 2 and 3, 1930, will disclose valuable results of past foundation experiences.*

# Spread Footings and Floating Foundations

*By* L. R. VITERBO

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A FOOTING is a structural unit used to distribute wall or column loads to the foundation materials. A spread or floating footing may be defined as a structural unit used to distribute a wall or column load directly to the soil upon which it rests, without the use of any other intermediate structural members. The superimposed load coming upon the soil is the total column load or wall load, including wind load, plus the weight of the footing, and this load may be ordinarily considered as uniformly distributed over the soil. The area of the footing is obtained by dividing the load by the allowable unit pressure on the soil.

BEARING CAPACITY OF SOILS

The bearing surface of a foundation must be proportioned in all points to the resistance of the soil, and to the load which must be carried by it. This, therefore, requires a thorough knowledge of the bearing capacity of the soil. Tests made directly on the bearing ground may give some indication of this. After opening a trench or a pit, the best method is to load known areas, and observe the settlement. In interpreting the results, however, it should not be overlooked that a small area will bear a larger load per unit of area for a short time, than a larger area will for an indefinite period. Thus, the area tested should be as large as practicable, and the test should continue for some time. These soil tests are somewhat tedious, and the results obtained are by no means easy to gage. In other words, the designer must use a considerable amount of good judgment in reaching conclusions. The following rule has been used in practice by most designers for a number of years and gives a close approximation of the carrying capacity of various soils.

1. Good, solid, homogeneous, compact, and proven rock has always a bearing capacity sufficient to carry any load superimposed thereon. It scarcely ever happens that rock is loaded with the full amount of weight which it is capable of sustaining. When bearing on rock, it is therefore unnecessary, except for practical purposes, to limit its carrying capacity.

2. Gravel or sand not subject to movements occasioned by subterranean water in motion may be assumed to bear safely 8,000 lb. per sq. ft.

3. Virgin soil, which has not been disturbed, which is undampened by wells, even by the roots of nature, and may be assumed to bear safely a maximum of 6,000 lb. per sq. ft.

These figures, which are semi-empirical, although derived from experience, allow the designer, in most cases, to determine the size of the bases of the spread footings which are to carry the superimposed loads.

FOOTING CONSTRUCTION, REINFORCED CONCRETE FRAME
11-Story Jefferson Hotel, St. Louis

Should a more accurate knowledge be desired, one can refer to the results of Rankine's investigations. He undertook to determine the effects obtained on a parcel of soil subjected to a vertical load such as the weight of a structure. This vertical load has a tendency to push the adjoining soil laterally, and at the same time to compress the soil directly under it. In order to prevent this lateral push, which would result in a settlement, it is necessary that the pressure of the adjoining ground counteract the lateral push.

Expressing this condition by a formula, Rankine has proved that the greatest vertical load that can be imposed upon a given soil is represented by the equation:

$$P = dp \times \frac{1 + Sin^2 \phi}{(1 - Sin \phi)^2},$$

in which $p$ = weight of earth per unit volume

$d$ = depth of the foundation excavation, below the ground level

$\phi$ = angle of friction of the earth, which varies according to the nature of same, and which can be easily determined from the angle of repose

In order to obtain a uniform distribution of load, a footing should, when practicable, be built so that its center of gravity will coincide with the point of application of the downward load. If the resultant downward load is not at the center of gravity of the contact area, the unequal pressures of the various parts of the footing may result in unequal settlements, or overloading. In such a case, the maximum pressure under the footing should be kept sufficiently low to preclude appreciable settlement. In any event, the resultant earth pressure should not be allowed to fall outside of the middle third of the contact area.

REINFORCED CONCRETE FRAME, 18 STORIES HIGH
Mayfair Hotel, St. Louis

Although the weight of earth varies, it may be assumed to average 100 lb. per cu. ft. The angle, $\phi$, varies with a given quality of soil, according to the degree of dampness or dryness. We may assume the following limits:

| | |
|---|---|
| Ordinary soil | 15 to 45 deg. |
| Wet clay | 17 to 20 deg. |
| Damp clay | 45 deg. |
| Sand | 21 to 37 deg. |
| Gravel | 39 to 48 deg. |
| Very compact soils | Maximum 60 deg. |

Let us assume that the depth, $d$, is 4 ft. 0 in. Then $dp$ = 400. Substituting these values for $\phi$ in Rankin's formula, at a depth of 4 ft. 0 in., we find the following values for various types of soil:

| | | | |
|---|---|---|---|
| Soil entirely immersed in water | $\phi = 0°$ | $P = 400 \times 1$ | = 400 lb. |
| Average soil | $\phi = 30°$ | $P = 400 \times 5$ | = 2,000 lb. |
| Good soil | $\phi = 45°$ | $P = 400 \times 17.5$ | = 7,000 lb. |
| Very compact soil | $\phi = 60°$ | $P = 400 \times 97.5$ | = 39,000 lb. |

These results should be somewhat modified for a given soil, according to its density, and also to the depth, $d$, below the general excavation, to which the pier excavation extends. As may be seen, these theoretical indications coincide fairly well with results arrived at by practical considerations.

When the designer assumes, either by test or otherwise, a certain quality and therefore a given reaction of the soil on which the foundations bear, it is very essential to be assured that there is a sufficient depth of the soil assumed under the footing. This, of course, may be discovered by borings, s, and may be shown roughly as follows:

Assume a square surface of contact whose side is $a$, with $L$ the vertical load imposed. It may also be assumed that if the load, $L$, is evenly distributed on the contact surface, $a \times a$, it is transmitted to the soil below the plane of contact along lines of 45 deg. from the edges of the contact surface.

Let $x$ be the assumed depth of a given quality of soil. Let $CD$ be a horizontal plane below the contact surface, at which the composition of the soil, and therefore its bearing capacity, changes. Let $S$ be the bearing capacity per unit of surface at $CD$. Then we can write:

$$S = \frac{L}{(a + 2x)^2}, \text{ or}$$

$$\frac{L}{S} = a^2 + 4ax + 4x^2$$

$$4x^2 + 4ax + \left(a^2 - \frac{L}{S}\right) = 0$$

from which we derive:

$$x = -\frac{1}{2}a \pm \frac{1}{2}\sqrt{\frac{L}{S}}.$$

This formula gives the depth to which it is well to bore under a given footing, receiving a given load, limiting the soil stress on the strata below the contact surface to a given figure.

For example:

Let $L$ = 250,000 lb.; let $S$ = 1,000 lb., and $a$ = 7 ft. 0 in.

Then the unit load will be $\frac{250{,}000 \text{ lb.}}{49} = \pm$ 5,000 lb.

showing that at least 4 ft. 6 in. of ground capable of sustaining 5,000 lb. per sq. ft. must be encountered.

### TYPES OF SPREAD FOOTINGS

Spread footings, which today are practically all of reinforced concrete, to save in excavating, materials, and

weight of the footing proper, may be divided into five classes:

Wall footings
Independent column footings
Combined footings carrying more than one column
Cantilever footings
Raft or mat foundation

As previously stated, a footing must be spread until the safe bearing capacity of the soil is not exceeded. All settlements need not necessarily be eliminated, but the structure should be so planned that whatever settlement does take place will be uniform.

In the ordinary type of building, that footing should be chosen in which the live load bears the highest percentage to dead load, and its area should be determined for the total load at the allowable soil pressure. The pressure of the dead load per unit area should then be determined, and the area of all other footings should be proportioned for dead load only, with this unit pressure. The foregoing implies that the ground is uniform throughout.

The ideal independent spread footing would be circular or hexagonal in form, but this being impracticable owing to the excess cost of excavating, the square or rectangular footing is generally adopted. The footing need not be of a uniform thickness throughout (except for light load), but may be made with a sloped top, or a stepped top. Footings with sloping tops contain less concrete than the stepped footing, but, unless the slope is flatter than 2 horizontal to 1 vertical, the top will require forms, which will offset the saving in concrete.

The stresses that come into play are the punching shear, which generally governs the depth of the footing at the base of the column, maximum bending moment, diagonal tension, and bond, all of which are well known.

Combined footings are simply inverted girders, or slabs receiving an upward pressure equal to the carrying capacity of the soil, throwing their end reactions on the columns which bear upon them. Therefore, the design of a combined footing is similar to that of a floor girder, and the same principles apply to both. It must, however, be borne in mind that the center of gravity of the downward load must coincide with the center of gravity of the upward reactions.

Cantilever footings are often resorted to when combined footings are expensive or impossible to use, that is, when encroachment upon adjoining property must be avoided, and when, at the same time, it is necessary to make use of the land close to the property line. In cantilever construction, the wall column footing and the footing of the nearest interior column are connected by a beam or strap, intended to support the wall column. To save excavation, the top of the strap is usually placed at the same level as the tops of the footings.

Raft or mat foundations are generally resorted to when the allowable pressure on the soil is small. The foundation is then spread over the whole area of the building, using either flat-slab or beam-and-slab type construction. In either case it is important that the unit pressure on the soil be kept as nearly uniform as practicable. The design of either type (flat-slab or beam-and-slab) is the same as for a floor system, except that in this case the uniform load is upward. In case of the beam-and-slab system, the slab may be under or over.

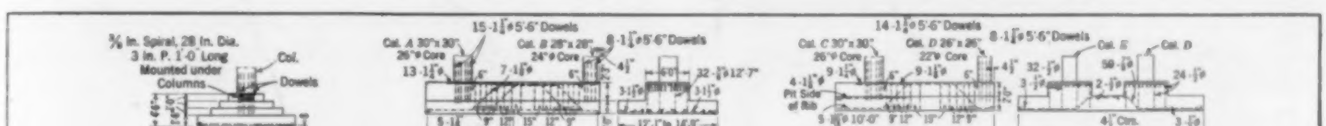



Fig. 1. Foundation Plan, Mayfair Hotel, St. Louis
A Typical Spread-Footing Design

# When to Use Piling

*By* A. C. EVERHAM

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

WESTERN CONTRACT MANAGER, RAYMOND CONCRETE PILE COMPANY, KANSAS CITY, MO.

WHEN the engineers engaged in the design of a structure have had extensive experience and are familiar with the characteristics of the several types of foundation available, a pile foundation will naturally suggest itself if soil conditions warrant. This will be the case when firm bearing soil is at so great a depth from the base of the footings that it is not economical to carry them down to it, and when such soil is not at too great a depth to be reached by piles driven by ordinary methods.

The depth of the desired strata and the character of the overlying material will determine whether the load can best be carried by point-bearing piles, friction piles, or caissons. Unfortunately, it is not always possible to reach a sound conclusion because of the absence of proper information as to the elevation of the firm bearing strata and the nature of the overlying materials. The taking of proper soundings and an appraisal of soil conditions should be a preliminary to the design of any important structure.

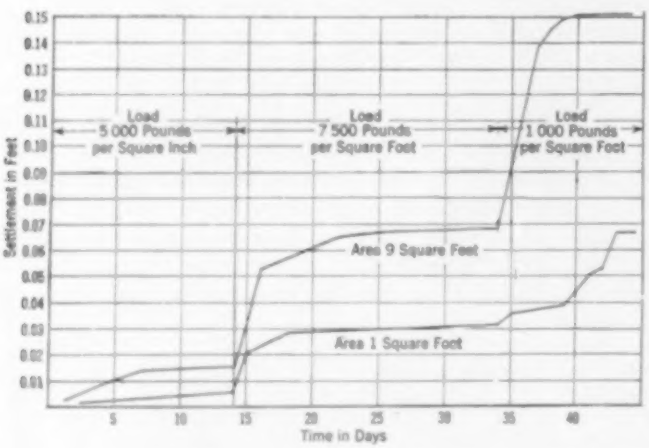



FIG. 1. RELATION BETWEEN SETTLEMENT AND DIAMETER OF LOADED AREA

Equal Unit Loads on Vienna Loess, According to Dr. Fritz Empberger

Many structures are completely designed, bids taken, and contracts awarded on the assumption, warranted or unwarranted, that a simple footing design, using ordinary pressure units of from 2 to 4 tons per sq. ft. will be adequate. Too frequently, when excavation has been completed, it is found that soil conditions are not as anticipated or as indicated by such casual investigation as may have been made regarding the foundations of nearby structures. It then becomes necessary to proceed with soil tests and explorations which should have preceded the design and contract for the structure. In many cases, had this been done, plans would have been materially altered and, in some rare instances, the project would have been abandoned. However, when plans have gone too far to be radically changed, the design of an adequate deep foundation becomes necessary. This means soil exploration, consisting generally of auger borings or test pits, as well as soil-pressure tests on limited areas in order to relate the results to the foundation design.

### INTERPRETING SOIL-PRESSURE TESTS

Soil-pressure tests are usually made on an area very much smaller than the size of a typical footing and, as is always the case when generalizing from too small a number of examples, costly errors arise from misinterpretation of their results. It has been the experience of many engineers that a soil-pressure test on a small area is not representative of the final results when a larger area is loaded proportionately. The results of such a test made by Dr. Fritz Empberger on Vienna loess are shown in Fig. 1.

The chart, Fig. 2, giving the results of tests on different areas of soil at Detroit, shows that, with the same load per square foot, large areas settled more than small ones. This fact has also been recognized by Prof. Charles Terzaghi in his paper appearing in TRANSACTIONS for 1929.

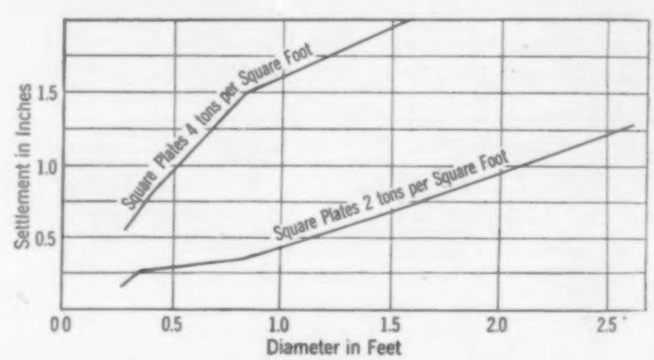



FIG. 2. SUPPORTING POWER OF CLAY

Detroit River Tunnel

Where the expense of loading an area as large as 9 sq. ft., shown on the chart, is fully warranted, the additional cost of a supporting test on a 1-sq. ft. area for the purpose of determining relative values is trivial in comparison to the benefits to be derived. In making tests on areas of different sizes, a curve might be plotted with proper interpolations and extensions to show what unit variations might be expected, as the areas of the tests differ. This would eliminate the necessity of determining the unknown constant required in Terzaghi's formula.

### TYPES OF PILING IN USE

There are three usual and distinct types of piles available for bridge and building foundations: wood piles, precast concrete, and cast-in-place concrete piles. Of the latter two, there are tapered and parallel sided.

Where the bottom of the footing is below permanent moisture level and the loads are not too heavily concentrated, wood piles are quite generally used and, on account of their low first cost, are apt to receive first consideration. But when ground-water level is at a considerable distance below the bottom of an economi-

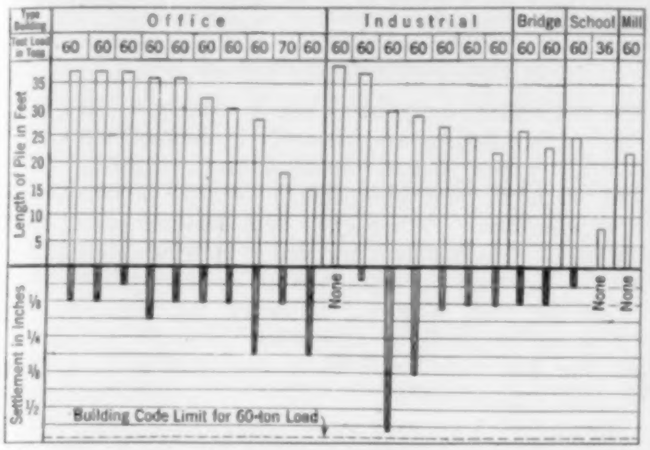



FIG. 3. CONCRETE-PILE SETTLEMENT TESTS
Missouri Valley

cal footing, or is likely to be lowered by subsequent drainage, concrete piles have been found to be very efficient and may reasonably be considered, even from the standpoint of first cost, as more desirable than wood piles.

Water levels, when once determined, are not necessarily permanent, and it is usually worth while to consider the possibility of the water table being lowered. Many buildings have had to be underpinned due to the rotting of wooden piles which, when driven, were completely submerged and assumed to be permanent. In some instances, it has been impossible to underpin the structure satisfactorily and replacement of the building itself has been necessary.

Deep excavation through materials which are unstable and even temporarily water bearing is very expensive. In the larger number of instances, where concrete piles have been adopted, the excavation, sheeting, and pumping items have been so large as to overcome the pile-for-pile cost comparison of concrete piles as against wood piles.

TABLE I. COMPARISON BETWEEN WOOD, CYLINDRICAL CONCRETE, AND TAPERED CONCRETE PILES

| | Average Load in Tons per Sq. Ft. of Frictional Area | Average Load in Tons per Lin. Ft. of Pile | Efficiency as Compared with Tapered Concrete Piles: Load in Tons per Sq. Ft. of Frictional Area | Efficiency as Compared with Tapered Concrete Piles: Load in Tons per Lin. Ft. of Pile |
|---|---|---|---|---|
| Wood piles | 0.381 | 1.145 | 0.547 | 0.470 |
| Cylindrical concrete piles | 0.420 | 1.79 | 0.603 | 0.735 |
| Tapered concrete piles | 0.696 | 2.437 | 1.00 | 1.00 |

The effect of taper on the driving and on the carrying capacity of piles is very interesting. In the course of driving, the tapered pile shows a gradually increasing resistance as it acts as a "constant wedge" in all directions, and all soil touching it throughout its entire length must be moved aside or compressed as the driving continues. In the case of a parallel-sided pile, the ground through which the point passes is merely displaced at the moment of passing and there is no appreciable tightening up on the sides during the process of driving. As a matter of fact, quite the contrary may be true, and it is often possible to move the pile appreciably by hand after it has been completely driven. Obviously, the frictional value of a parallel-sided pile is very much less than that of the tapered pile, with its vertical component due to its wedging contact with the soil. Another effect of the taper is the development of a given resistance under the hammer in a shorter length than would be required to develop the same resistance with a parallel-sided pile. Again, the character of the soil in which the pile develops its load must be considered in determining values.

## METHODS OF TESTING PILES

A growing realization of the importance of a proper foundation for any structure has resulted in an increasing desire on the part of the engineer, architect, and even the layman owner, to be shown that the contractor is delivering, in the way of security, what the owner is contracting to pay for. This is perhaps more definitely the case with reference to piles than to caissons, owing to the fact that a concrete base on rock or very hard soil instinctively inspires confidence. On the other hand, a pile is merely driven to a certain resistance under the hammer, and the average man has no means of knowing just what this impact means in terms of load-carry-

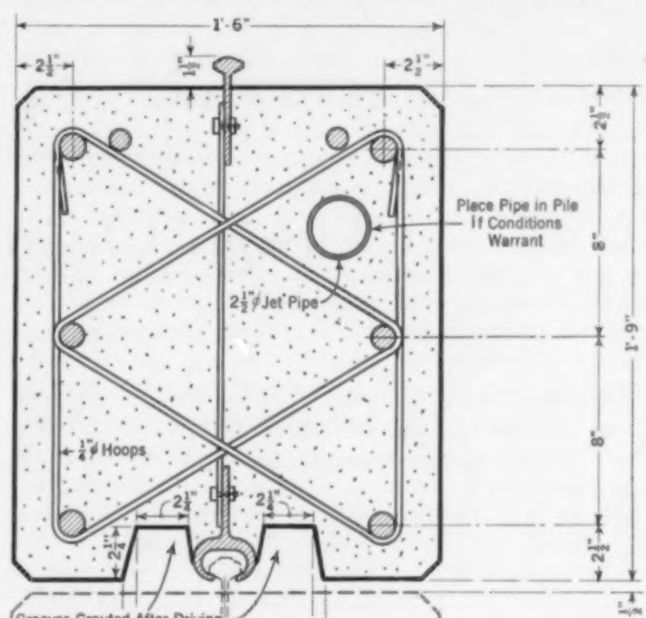



FIG. 4. HEAVY CONCRETE SHEET PILING
Cahokia Power Station, St. Louis

ing capacity. The driving of piles results in an equalizing of the soil values throughout the entire area if the carrying capacity can be clearly related to the driving resistance. To meet this situation, it is frequently desirable to build up a test load on a pile or group of piles.

A large number of tests made on tapered concrete piles in the Missouri Valley, Fig. 3, indicates that 60

tons is about the ultimate limit of load for test purposes without exceeding allowable settlements. In view of the generally accepted factor of safety of two, a reasonable working load limit is indicated to be about 30 tons. That few piles penetrate exactly the same soil, even within the limited area of an ordinary building foundation, is proven by the fact that in the ordinary job there is likely to be a difference of 50 per cent in extremes of length.

In the vicinity of Kansas City, the principal use of piles is for foundations of buildings or bridges, and a comparatively small percentage of them are driven in water. However, for such jobs as the Cahokia Power Station in St. Louis, where the loads per pile are very heavy and very long piles were required, precast piles were driven to insure the safety of the foundations against the encroachment of the Mississippi River. As a further measure of protection, a bulkhead of very heavy concrete sheet piles was driven to protect and retain the sand and gravel around the foundation of the machinery and building proper. A cross section of the concrete sheet piles used is shown in Fig. 4. They were manufactured on the site, from 70 to 75 ft. in length, and were jetted and driven into place through sandy and gravelly subsoil. The interlocks were grouted to insure against leakage.

### FOUNDATION PILES IN WATER

The use of precast piles in water work has grown to a considerable extent in the past few years. Such piles, with a maximum length of 115 ft. and a cross section of 24 in. by 24 in., were driven for a bridge at Newport News. They are believed to be the longest precast piles ever driven. The problem of handling such long piles to prevent deflection cracks and to secure proper alignment was one requiring very careful treatment, and unusual and heavy equipment was needed for this work. There were four piles in the leads at one time and two hammers operating simultaneously. These piles were required to be driven with great accuracy of alignment.

### DEPENDABILITY OF PILES

In the highly competitive age in which we live, all types of foundations are naturally in competition with all other types—spread footings, mats, caissons, and piles, all have their advocates. No type is adaptable to all situations. While each type has its place, the spheres of economy overlap, and it sometimes happens that the cleverest salesman sells his product, which may not be the most suitable. However, the mere driving of the pile, if properly interpreted, provides assurance that the load which is to be concentrated upon it will be amply taken care of.

Spread footings usually settle to some extent, generally uniformly but not always, and it is usually uneven settlement that does the damage.

In conclusion, I repeat that there are uses for all types of foundations. Piling has been used heretofore and will continue to be used for important structures, and, when properly installed, it should prevent settlement, or, at most, permit only uniform settlement. My personal experience has been that, with the proper selection of the type of piling required, proper equipment, organization, and workmanship, a pile foundation is a safe and dependable one.

# Chicago Open-Well Method

*By* W. J. NEWMAN

W. J. NEWMAN COMPANY, CONTRACTORS CHICAGO

GENERALLY, the soil underlying the Chicago area is a soft blue clay of uniform texture, which has a consistency great enough to permit vertical walls of heights from 3 to 6 ft. to stand without crumbling for sufficient time to place lagging and rings. This blue clay becomes harder as excavation proceeds, and ultimately becomes a hard, dry clay which, in the Chicago territory, is called hardpan. Below this, the entire district is underlaid with a bed of hard limestone, the top of which lies as deep as 130 ft. below the surface in some places, but there are some spots in and about the city where the limestone outcrops.

### OPEN-WELL EXCAVATION

It is on such a soil condition that the Chicago open-well method, devised by the late Gen. William Sooy Smith, M. Am. Soc. C.E., about 40 years ago, depends for successful operation. Its economy lies in the fact that a minimum of material and equipment is required and that, where the architect or engineer permits, the rings which hold the wood lagging in place may be removed during the concrete operation and used repeatedly in other wells.

The outstanding feature of the Chicago method is its simplicity. Under ideal conditions, when there is no water present, and when the clay is sufficiently rigid to be self-sustaining for heights of from 3 to 6 ft., caissons can be constructed quite rapidly. The first move is to assemble a set of tongue-and-groove maple lagging, the inside diameter of which will be that of the finished caisson. The lagging consists of boards 2 or 3 in. thick with beveled edges. Ordinarily, a set of lagging is 5 ft. 4 in. high, although other lengths are used. A hole is dug to the depth of the set of lagging and to a diameter equal to that of the outside diameter of the set. The lagging is then set in the hole vertically, interlocked, and two sets of steel rings applied to the inside.

These rings consist of two semicircular arcs each, and act to resist the inward thrust of the ground against the lagging. The older type of ring consists of two curved steel bands with both ends bent. The bent ends are connected with bolts to form the complete ring. A

more recent type of ring is made up of small structural channels with $^{3}/_{4}$-in. iron lugs welded to the ends of the arcs for the insertion of bolts. Rings thus formed from channels are lighter, and since they require less metal and are easier to handle, are gradually replacing the older type.

When the first set of lagging has been placed in the shallow excavation, it is carefully centered. The work of excavation then proceeds another 5 ft. 4 in. and another set of lagging is placed immediately beneath the first set. Each set is centered as it is set, thus carrying the caisson down plumb.

Excavation is done by hand, and the material is loaded into circular buckets about 20 in. in diameter and 2 ft. in height, which are hoisted with an electrically operated niggerhead winch. When the excavation has been carried down to what appears to be bedrock, a hole is usually drilled to test its soundness; not infrequently, the bedrock is overlaid with seamy or shell rock. When there is no doubt that the rock bed has been reached, the floor of the caisson is leveled and trimmed.

Concrete is mixed at a central mixing plant, wheeled to the hole, and dumped directly into the well, no chutes or spouts being used. As the work of placing the concrete progresses, the rings are quite often withdrawn for use on other wells. The usual mix for concrete in caissons constructed in Chicago is 1:2:4, but in some places a 1:1:2 mix is used. Ordinarily the top 4 ft. of the caisson is reinforced with hoops and vertical rods. The mix and reinforcing in the caissons depend, of course, entirely on the design and the loads to be carried.

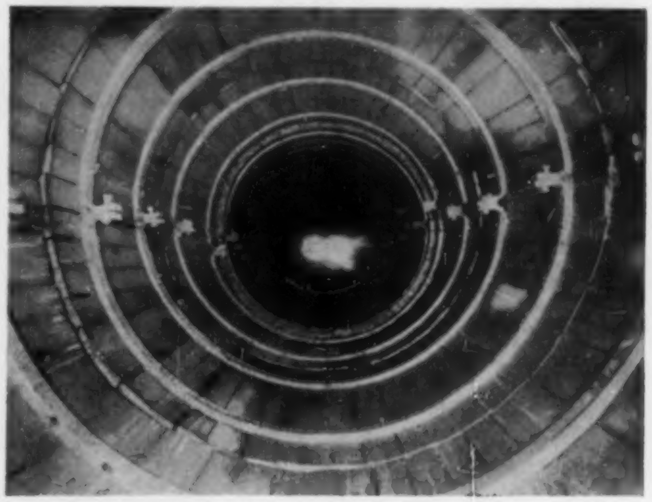
### WATER HAZARDS

A large part of what now constitutes lake frontage, particularly that adjacent to the Loop, has been formed

Open-Well Caissons, Pure Oil Building, Chicago
Note Lagging, Rings, Winches, and Concreting

by filling along the original shore line. In many sections extending some distance from the lake it becomes necessary to improve property for building by filling swampy spots. Much of the property near the lake is wet and sandy on the surface. Below this sand stratum we have the same blue clay that we find in other parts of the city. This surface condition necessitates the employment of special methods in the upper part of the caisson. Another special condition is encountered throughout most of the area in the form of a stratum of sand and water or quicksand between the hardpan and rock.

Where the water-bearing surface stratum is shallow, a



Looking Down Into a Caisson, Stop and Shop Building, Chicago
Forms Used in the Widening-Out Section Adjacent to Lot Line

second independent set of lagging is placed outside of the first set. It is carried to a point below the line of firm clay, and clay is puddled in the space between the two circles of lagging. Where a sand and water stratum reaches a considerable distance below the surface, steel sheeting is often employed. This is driven to a point below the line of firm clay, and in a circle somewhat larger than that required for the caisson under construction. The sand is then excavated from inside the steel sheeting, and an inner ring of lagging of the proper size for the caisson is set. In this case the wood lagging is set from the clay upward to the surface or a few feet below, depending on what the finished grade of the caisson is to be. As the wood lagging is placed, the space between it and the steel sheeting is filled with clay and puddled.

### USE OF CONICAL LAGGING

Where sand and water appear at a distance below the surface, the problem is more complicated. As the work proceeds downward, the caisson contractor must estimate the point at which water and sand will appear, as well as its extent, and make his plans accordingly. This disposition consists of "widening-out" or increasing the diameter of the well, which is accomplished by using lagging sets in the form of truncated cones.

In the first set of conical lagging, the upper or smaller base has the diameter of the caisson, and the lower diameter is from 6 to 9 in. greater. The diameter of the upper base of the second set of lagging is the same as that of the lower base of the first, while the lower base of the second set is again 6 to 9 in. greater than the upper base. This flared or conical lagging is used until the diameter of the well has been increased from 1 to 3 ft., depending upon conditions.

The point at which the widening is begun must be estimated to a nicety in order to make the maximum width occur at a point approximately 6 ft. above the sand and water, to permit of placing one straight set of lagging before the water-bearing stratum is encountered. It is here that a familiarity with conditions gained through long experience in underground work in the district is most valuable to the contractor. Should he fail to widen out before encountering wet conditions, it becomes necessary to go back, removing lagging to the point where widening should have started, with consequent expense and lost time.

### DRIVING THROUGH WATER-BEARING STRATA

With the widening completed, either overlapping wood lagging sets or steel sheeting may be used, the choice depending on the probable extent of the sand and water. If the wet stratum does not exceed 15 ft. in depth and does not contain a large percentage of water, wood lagging may be used. At a point about 6 ft. above the sand and water, a straight set of lagging is placed, with the same diameter as the base of the final flared section. A second set of vertical lagging is driven into the wet sand, flush with the first vertical set, but overlapping it from 2 to 5 ft.

After the driving, excavation in the wet material is begun. Assuming that 3-in. lagging is used, the diameter of the second set of vertical lagging, that is, the first driving set, is 6 in. less that that of the straight set. Subsequent sets of vertical lagging are driven in the same manner, and the excavation proceeds until the wet stratum has been penetrated. The driving sets are ordinarily 7 to 8 ft. long. At the end of the wet stratum, the overlapping lagging must have reduced the diameter of the well to the original diameter at the top. In a condition such as that described above, it would be necessary to start the widening-out at a point 15 to 25 ft. above the sand and water.

Where the extent of the wet soil or its consistency is such that the maximum allowable flare and the maximum necessary overlap would result in reducing the diameter of the caisson to less than that required when rock is reached below the sand, another method is used. The well is widened out only about one foot. Then, instead of using wood lagging, steel sheeting is employed. At the base of the straight set this is driven all the way through the sand and water to firm clay, and the resulting oversize cylinder is excavated. The purpose of widening-out is to allow room for driving the steel sheeting.

In both methods, pumps are in the well at all times. The pumps used are vertical with direct coupled motors and centrifugal action. They are lowered into the well with the intake hose hanging beneath and are operated from a starting box by the same man who operates the winch. The largest of these pumps will deliver 500 gal. per min. at the surface. In all of the widened-out wells, concrete is poured solidly throughout the entire excavation. All of the concrete outside of the main stem of the caisson, of course, is additional to the caisson as designed, but might be considered part of the construction cost.

CAISSON DIGGING WITH ROTARY MACHINE
Chicago, Milwaukee, and St. Paul Railway Bridge, Monroe, Wis.

### ROTARY EXCAVATION MACHINES PROVE SATISFACTORY

Another method of constructing open-well caissons, recently devised and patented, makes use of a specially built machine, consisting of a rotary rig driven by a powerful gasoline engine, and mounted on caterpillars. The rotary, in turn, drives a specially constructed shaft made up of sections of 10-in. pipe on the bottom of which are fastened auger or disc blades which do the actual digging. As the drilling proceeds, water is pumped through the hollow shaft and jets in the blades. As the water is pumped into the hole the resulting muddy liquid overflows the well into a sump, from which it is then recirculated by a pump and forced back through the cutting tools into the hole. The consistency of the mud is regulated by adding clear water to the sump. As long as the muddy liquid remains in the hole, there is no danger of the collapsing or slumping of the side walls. When the bottom is reached, the auger and shaft are removed and a steel shell is dropped into the hole. After the steel shell has been placed the liquid is pumped out and the thick material in the bottom is baled out with a specially constructed orange-peel bucket. A man is then lowered to the bottom of the well to inspect the steel shell and to do whatever necessary cleaning up is required. The hole is then ready to be filled with concrete.

### TWO METHODS USED FOR SEALING OFF WATER BEARING STRATUM

Under extraordinary conditions, where a water-bearing stratum lies directly above the rock, it is necessary to seal the steel shell to the rock before cleaning out the hole. Pipes 2 or 3 in. in diameter are put down to the rock on the outside of the shell, and concrete is forced down through them by air, filling the space between the shells and the clay to a height deemed sufficient to seal out the water. A second method is to place concrete in the bottom of the hole with a tremie bucket, allow it to set, and then cut out the core, leaving a ring of concrete around and against the steel shell and resting on the rock. The holes are then cleaned out and concreting proceeds in the same way as for holes dug by hand.

# Use of Caissons in St. Louis Sub-Soil

By S. W. Bowen
Member American Society of Civil Engineers
Second Vice-President, Fruin-Colnon Contracting Company, St. Louis

BEDROCK in the St. Louis district consists of a fine grained white limestone on which the usual unit pressure specified for foundations of high buildings is 20 tons per sq. ft. In the downtown business section of the city the depth of the rock below the street surface varies considerably, from about 50 to 80 ft.

Wherever any considerable area of rock is exposed, the surface is found to be much folded and crumpled; in some instances the depressions are large enough to hold a horse. This unevenness of the rock explains the eccentric results sometimes obtained in making test borings.

As the upper layers of rock are more or less decomposed, in some locations several feet of rock must be removed before solid limestone, capable of sustaining the concentrated loads from high buildings, is encountered. As a matter of precaution, the rock on which a foundation is to rest is drilled to a depth of from 6 to 8 ft. to assure at least that thickness of solid rock without horizontal mud seams.

### CAVES IN LIMESTONE BEDROCK

At various points in the city, caves have been found in the bedrock. Probably the largest and best known of these is Uhrig's Cave, located under the site of a once well known summer resort by that name at Jefferson and Washington Avenues. It extended down nearly 100 ft. below the surface of the ground and was very extensive. It has been covered over, and the site is now occupied by the Coliseum Building.

Other caves of like nature are scattered about town, and a number of them were used by breweries, in the early days, for cooling purposes. While these caves usually lie so far below the rock surface as to interfere but little with ordinary foundation work, their presence must be looked for wherever heavy, concentrated loads are to be supported.

In the river opposite the business section of St. Louis, the bedrock slopes considerably from west to east, the rock at the eastern inner harbor line being about 80 ft. lower than that at the west line. In sinking bridge piers along the east side of the river in this area, a layer of large boulders, several feet in thickness, is encountered. It is interesting to note that many of these boulders are of stone foreign to this locality and evidently have been rolled down by the river from very much farther north and deposited in the low part of the bedrock basin. Some of them are nearly a cubic yard in size and almost perfectly rounded.

In the stream bed, the bedrock has an entirely different appearance from that on shore; surface irregularities and loose materials have been scoured off as though by glacial action, and the surface left clean. This bedrock also has the peculiar appearance of having been gouged as with a tool, the marks running parallel to the stream, and being from 6 to 8 in. in width.

In general, material above the rock consists of stiff clay with, in some cases, sand, gravel, and boulders in the hollows immediately over the rock. This is excellent material through which to sink shafts, except for the presence of pockets and streaks of quicksand or fine water-bearing silt, which are frequently found, particularly in the Mill Creek Valley.

### OLD MAP ASSISTS IN FOUNDATION WORK

An examination of the map of St. Louis, made about 1840, shows Chouteau's Pond occupying Mill Creek Valley with various small streams, ponds, and sink holes scattered around. It is in the beds of these streams and ponds that the fine silt is found. To further complicate matters, considerable water from springs and underground streams is encountered at such points as these.

This map, a portion of which is reproduced in Fig. 1, unfortunately does not indicate who made it or the survey on which it is based. It was the best belief of the late Robert Moore, M. Am. Soc. C.E., who owned the original map, that it was prepared by Robert E. Lee while a young army lieutenant stationed at Jefferson Barracks. It has been found to be remarkably accurate and has been of great service in helping to determine what the probable soil conditions are at the sites of the proposed jobs. The location of old streams and ponds can even now be traced by the settlement cracks in the buildings occupying these sites.

A Typical St. Louis Caisson Job
Civil Courts Building

ILLINOIS SIDE PRESENTS DIFFERENT PROBLEMS

On the Illinois side of the Mississippi River, opposite St. Louis, the conditions are more difficult. Here the soil back to the bluffs consists of fine silt deposited by the river, underlaid with sand, which becomes coarser as the depth increases. Gravel and boulders are found overlying the rock, which is 120 ft. or more below the ground surface. Owing to these conditions, only foundations for extremely heavy structures are sunk to rock, and then only by the pneumatic method.

CONCRETE CAISSON DEVELOPED

In order to meet the conditions existing on the St. Louis side of the river, there has been developed, in recent years, a reinforced concrete caisson which can be sunk to rock by the open-well method, using air locks only where quicksand and water are encountered in such quantities as to make its use absolutely necessary.

These caissons are hollow cylinders whose inside diameter is usually determined by the size of the bucket used for excavating. The walls are made of such thickness as to give the proper outside diameter to carry the load to be supported. An outside diameter of 8 ft. is frequently used with 9-in. walls. For smaller sizes, excavation is either done by hand or by a small orange-peel bucket. No metal cutting edges are used, except in cases where boulders and other obstructions are expected to be found.

Reinforcement consists of sufficient metal, both vertical and circumferential, to prevent cracking of the walls, and this is placed in both wall faces. The minimum reinforcement generally used consists of bars $^5/_8$ in. in diameter, 12 in. from center to center for the hoops, and 24 in. from center to center for the verticals. Where it is likely that air will be used, the reinforcement is designed to take the unbalanced internal pressure, using a unit stress of 15,000 lb. per sq. in. on the steel.

Buildings such as the Statler Hotel at 9th Street and Washington Avenue, the Lennox Hotel directly opposite, and the Civil Courts Building in the block bounded by 11th, 12th, Market, and Chestnut Streets, are carried on caissons of this type. A number of cement storage silos at Prospect Hill in the northern part of the city have the same type of foundation. At both the Statler and Lennox Hotel sites, air was used on certain of the caissons where there was a possibility that sand might flow out from under adjoining buildings and into the foundation shafts.

STARTING THE CAISSON

In starting the caisson, a pit is dug about 8 ft. deep and 4 ft. greater in diameter than the caisson. In this pit the first section of inside forms is set up on blocking; the reinforcement is placed and then the outside forms. The forms are usually built in sections 10 ft. high with three or four parts to the circle of tongue-and-groove lagging secured to angle iron rings, well braced to the walls of the pit. The first section of the cylinder is then poured, using early strength cement; the forms are removed and the concrete shell is blocked and wedged against vertical timber guides in the pit.

Excavation is started by hand, using "potter" buckets and a caterpillar crane to handle the excavated materials. The shell is eased down into the excavation, care being taken to see that it is properly aligned and plumbed. The forms are reassembled, and the next section of caisson poured, giving additional weight for sinking. Excavation is carried on from this point by means of a


FIG. 1. ST. LOUIS IN 1840
From the files of Baxter L. Brown, M. Am. Soc. C.E.

clamshell bucket handled by a caterpillar crane. One or two men are kept in the hole to trim and control the excavation.

AIR LOCKS USED IN QUICKSAND

When a stratum of quicksand or other water-bearing material is struck, which makes hand work dangerous, the men are withdrawn and the excavation and sinking are pushed as rapidly as possible by the clamshell until the caisson again reaches clay. The water is then pumped or bucketed out and the work is resumed as usual.

In cases where the rock is overlaid with clay, no difficulty is usually experienced in cleaning out and removing the loose rock in the open. However, where sand and gravel are found next to the rock, it frequently becomes necessary to use air. In this event an ordinary air lock is bolted to the top of the caisson and the usual air methods are followed.

Considerable resistance to sinking sometimes develops, and various means are used to overcome it. Concrete blocks, pig iron or other heavy materials are used for weights, and water jets are used to lubricate the outside of the shell. In one instance a barrel of axle grease was used to lubricate the outer surface of the concrete shell. It had the desired effect—at least the caisson settled readily.

When the usual methods of weights, jets, and axle grease do not suffice, light charges of dynamite have been used on the outside of the shell near the cutting edge. This is only done as a last resort, however, as there is some danger of injuring the shell. The charges are put down in pipes driven along the side of the shell, and are discharged by a battery. In some cases the shooting is done from the inside, but this is not quite as effective as the former method, and is more likely to injure the shell, especially in the presence of water.

After the rock has been cleaned off down to a solid stratum and drilled to determine the thickness of this, the interior of the shell is filled with concrete, somewhat leaner than that used in the shell itself.

# A Caisson Foundation Job

*By* O. E. Mogensen

Member American Society of Civil Engineers
Secretary, F. L. Smidth and Company, Engineers, New York

THE open-well type of caisson foundation, used extensively in the vicinity of St. Louis, is well illustrated by the foundations for the Missouri Portland Cement Company's new early strength Velo plant, built during 1927 and 1928. It is located 8 miles north of St. Louis at Prospect Hill, Mo., adjacent to the original cement plant of the company.

The site for the new plant is located about 1,000 ft. from the west bank of the Mississippi River and is on a decided downward slope toward the river. Preliminary auger borings extending from only 40 to 45 ft. below the ground indicated the ground to be an alluvial deposit, undoubtedly a part of an old bend of the Mississippi River. Adjoining property belonging to the cement company showed a tendency to slides whenever an excavation was opened to any considerable depth, caused by the presence of water-carrying layers of fine sand interspersed between deposits of various kinds of clay.

Construction of a modern cement plant requires more careful attention to the substructures and foundations than was formerly necessary. Older stock houses, spread over a considerable area, have been superseded by concrete silos extending to heights of from 60 to 90 ft. Obviously, the latter cause large unit loads on the ground, varying from 3 to 5 tons per sq. ft. when the silos are placed on a spread foundation slab.

Foresight and thoroughness were shown by the owners of the Missouri Portland Cement Company in giving careful consideration and study to the types of foundations best adapted for the various structures, those for structures which would permit of slight settlement and those where all settlement should be avoided. It was very quickly ascertained that spread footings could be used only for foundations of steel frame buildings or for some of the large reinforced concrete mix basins, where the unit load could be kept between 2,500 and 3,000 lb. per sq. ft.

WASH BORINGS MADE

An experienced engineering concern was engaged to make wash borings, and 12 such borings were made at various points over the entire building site. A careful record was kept of the materials found, and the penetration of a steel rod was recorded whenever a change of material occurred. From 10 to 20 ft. below the ground level, yellow clay was found, and under this blue silt with layers of sand and soft clay gumbo, the latter with a less bearing capacity than the overlying yellow clay.

Beginning at approximately 40 ft., brown clay was encountered with a better bearing capacity than the upper strata. Below the brown clay were a few boulders of shale overlying a hardpan and fire clay into which the steel rods were driven to refusal. The hardpan and fire clay varied in depth below the surface from 40 to 82 ft., indicating a decided downward dip of the fire clay in a northeasterly direction, that is, in the opposite direction to the top surface of the ground.

This condition, illustrated in Fig. 1, was rather unfavorable in respect to the location of the cement silos, which had to be placed on the high ground where the distance to the fire clay was the greatest. The borings showed a marked difference in the elevation of the ground water; some of the holes showed water within a few feet of the ground level, whereas others showed it from

20 to 25 ft. below this level, indicating a considerable variation in the elevations of the water-bearing strata of fine sand.

### TEST PILES LOADED FOR BEARING POWER

Simultaneously with the borings, four test piles were driven: two wooden piles, one composite pile, and one all-reinforced concrete pile. The two wooden piles were, respectively, 40 and 50 ft. long. Although they were driven down until their heads were flush with the surface of the ground and then followed up with 20-ft. followers, they did not reach hardpan. The composite pile consisted of a 50-ft. wooden pile with a 13-ft. concrete top, making a total length of 63 ft. This pile struck hardpan, and when loaded up to 50 tons it showed no settlement. At 60 tons there was a total settlement of $^3/_{16}$ in., with readings taken over a period of nearly a month.

The all-reinforced concrete pile measured 14 in. in diameter at the top and 7 in. at the point, and was 46 ft. long, but did not reach hardpan. It was tested to 75 tons with no settlement up to 20 tons, and with a total settlement of $^3/_{16}$ in., readings being taken over a period of 17 days. It may be of interest to note that this pile was made from the Missouri Portland Cement Company's high, early strength cement, Prestolith Velo cement, and was driven with a 5,000-lb. hammer, 48 hours after it was cast without injury to the concrete. Table I shows the driving and loading record of this pile.

In order to ascertain the thickness of the fire clay and hardpan and the location of rock, two 6-in. drill borings were made, one under the cement silos and one under the clinker silos, about 350 ft. apart. In this way solid limestone was found under the cement silos 137 ft. below the ground level. Under the clinker silos limestone was found 82 ft. below the ground level, and alternating layers of fire clay and limestone until solid limestone was found at 130 ft. below the ground.

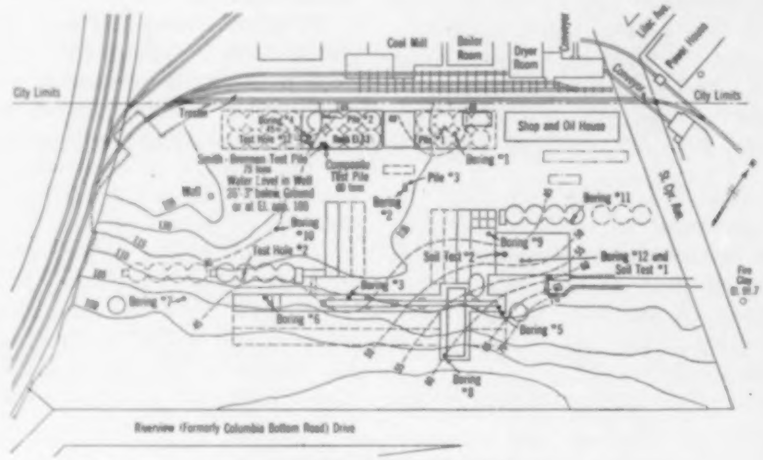



FIG. 1. SITUATION MAP OF THE VELO CEMENT PLANT
Missouri Portland Cement Company

### CEMENT SILOS CONCENTRATE HEAVY FOUNDATION LOADS

The silo structures consisted of eight cement silos in clusters with interspace bins, each of the silos 32 ft. in diameter by 70 ft. high; four rock silos 35 ft. in diameter by 60 ft. high; and four clinker silos, also 35 ft. in diameter by 60 ft. high. Materials to be stored in these silos weigh from 100 to 115 lb. per cu. ft. The three silo structures were placed at different locations on the building site; they weighed, respectively, when filled, 32,620 tons, 16,640 tons, and 18,560 tons.

Results of the borings and test-pile experiments presented a rather unfavorable showing for the use of piles, at least for the silo structures, which would require a spacing of the piles of not more than 2 ft. 9 in. on centers in order to keep the foundation slab within reasonable limits. Of necessity, the piles would be of the friction type, as cluster piles would have been inducive to settlement. Settlement had, by all means, to be avoided, because of the necessity of preserving an accurate alignment of the particular handling machinery selected for charging and extracting the materials from the silos.


FIG. 2. SMITH BRENNAN TEST PILE AND BEARING TEST TABLE

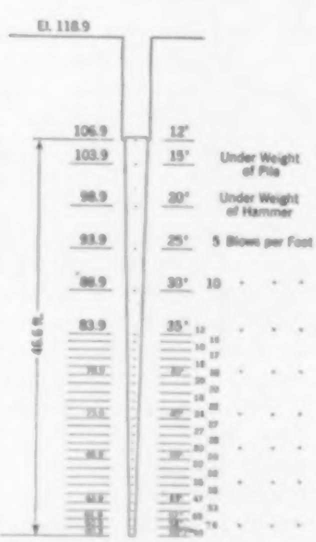



FIG. 3. LOG OF BORING NO. 4
Typical Pile-Driving Conditions

### PILES REJECTED

Before deciding to use caissons instead of piles for the silos, the owners sank a test caisson, so located as to form one of the permanent supports of the cement silos in case caissons were finally adopted. This caisson accomplished the following purposes: it checked the wash borings, determined the character and position of

TABLE I. LOADING RECORD OF REINFORCED CONCRETE PILE

| DATE | TIME | LOAD IN POUNDS | TOTAL SETTLEMENT |
|---|---|---|---|
| 5- 6-27 | 2:00 P.M. | 10,800 | None |
| 5- 7-27 | 10:00 A.M. | 40,300 | None |
| 5- 9-27 | 9:30 A.M. | 70,600 | $^1/_8$ in. |
| 5-10-27 | 9:30 A.M. | 100,300 | $^1/_8$ in. |
| 5-11-27 | 9:30 A.M. | 120,300 | $^1/_8$ in. |
| 5-12-27 | 9:30 A.M. | 120,300 | $^5/_{32}$ in. |
| 5-13-27 | 9:00 A.M. | 120,300 | $^6/_{32}$ in. |
| 5-14-27 | 8:00 A.M. | 120,300 | $^3/_{16}$ in. |
| 5-16-27 | 8:00 A.M. | 120,300 | $^3/_{16}$ in. |
| 5-18-27 | 7:30 A.M. | 150,500 | $^3/_{16}$ in. |
| 5-20-27 | 7:30 A.M. | 150,500 | $^3/_{16}$ in. |
| 5-23-27 | 7:30 A.M. | 150,500 | $^3/_{16}$ in. |

the water-bearing strata, made possible an examination of the bearing capacity of the fire clay, and, finally, enabled the contractor to submit a more accurate estimate for the work than otherwise would have been possible.

This caisson was driven by means of steel cylinders (of the Gow type), which measured 54 in. in diameter at the top and 34 in. in diameter at the bottom, and extended 82 ft. to the fire clay. No difficulties were met in sinking it except that more water was encountered than expected. The method proved to be entirely feasible. The wash borings were found to check very accurately, and the fire clay proved to be of sufficient firmness and stability to permit of belling out in order to obtain a spread-caisson footing. At the bottom of the cassion, it was found capable of sustaining a safe working load of 10 tons per sq. ft.

Bids were also called for the open-well type of concrete shell caissons, all of which were to be of sufficiently large diameter to permit of excavation by clamshell bucket.

### Caisson Support for Concrete Chimney

In order to ascertain the practicability of this open-

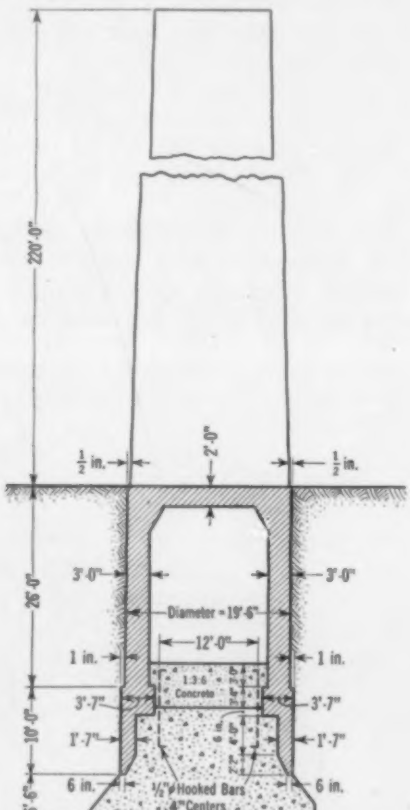



Fig. 4. Chimney Foundation
Conical Excavation Below Caisson

well method, it was decided to sink a concrete caisson to support the high concrete chimney, lined with fire brick to the top. The chimney is 19 ft. in diameter, 220 ft. high, and weighs about 1,100 tons. The caisson, which was 19 ft. 6 in. in outside diameter, with a wall thickness of 3 ft., struck fire clay at one of the highest elevations on the site, 42 ft. below the ground surface. The first section of the caisson, the cutting edge, was 10 ft. high, and was made from the company's high early

Caisson for Stack Foundation
Setting Inside Form for Next Section

strength cement, and the entire caisson was sunk very quickly and satisfactorily. When the caisson had been sunk to within a few feet of the fire clay, heavy timber posts were set under it to support the structure against further downward movement while the excavation was continued down six to eight feet to the fire clay. This was an exacting operation. The fire clay was then belled out in the form of a truncated cone so that the bottom had the desired bearing area, as illustrated in Fig. 4. The bottom of the bell of the foundation measures approximately 26 feet in diameter.

Special provision was made for the transfer of the overturning forces in the shell to the bell of the caisson. The bell was filled with 1:2:4 concrete up to six inches above the bottom of the caisson shoulder, and the caisson shell supported on it. Half-inch round bars, on four-inch centers, and hooked at each end, were imbedded in the concrete and extended about half their length above the caisson shoulder. The caisson was next filled another 6′4″ with 1:3:6 concrete, tying the bell footing to the concrete caisson shell. It was not found necessary or desirable to fill the upper half of the inside of the caisson shell with concrete or other materials. As a foundation for a tall chimney, this type of foundation is a departure from the usual spread or pile foundation, and, to my knowledge, is the only case on record where an open-well caisson formed an extension of the reinforced concrete chimney shell, 42 ft. below the ground level.

In reality, this method of sinking a concrete caisson is just the reverse of the construction of a monolithic tapered concrete chimney. In the case of the chimney, the sectional form is raised the required 8 to 10 ft. every time a section is cast. In the case of the concrete caisson,

the sectional form is kept in a stationary position at or rather below the ground level, while the cylindrical concrete shell is gradually lowered into the ground as a monolithic cylinder.

The chimney caisson was heavy enough to sink of its own weight as the material was excavated from below its cutting edge, but the smaller caissons were loaded with concrete blocks, as illustrated, to overcome skin friction, even after the clamshell had excavated the material below their edges.

GENERAL VIEW LOOKING SOUTH
Concrete Stack Rising Behind Silos

Four longitudinal tunnel walls under each row of silos were required by the layout of the machinery for emptying the silos; the number and location of the caissons were arranged to suit these walls. The layout of the steel caissons called for 12 caissons to each silo, or 170 caissons in all; whereas there were only 4 concrete shell caissons to each silo, or 64 in all. The open-well concrete caissons measured 8 ft. in outside diameter and had a wall thickness of 10 in. Both types required belling out of the concrete at the bottom, the depth and diameter of the bell being proportioned to the individual concentrated loads. The concrete caissons were enlarged at the bottom to cones varying from 12 to 16 ft. in diameter.

### CONCRETE CAISSONS COMPARED WITH STEEL

After the bids for the two types of caissons and for the concrete piles had been compared, it was decided to use caissons under the silo structures. In comparing the bids for the larger number of steel caissons, of smaller diameter, with the smaller number of open-well concrete caissons, of larger diameter, after due consideration had been given to the greater yardage of concrete between the tops of the open-well caissons and the bottom of the silos, they were found to be very close, with a small margin of advantage in favor of the open-well concrete caissons. The time promised for execution also compared very closely. The owner's selection was in favor of the open-well concrete caissons.

Where water-bearing strata are prevalent, the open-well concrete caisson has an advantage over the steel type in that the concrete wall forms a seal against the passage of the ground water after the caisson has passed through the water-bearing strata.

Sinking and construction of these caissons were performed in an entirely satisfactory manner. Their tops were kept very closely to the prescribed center distances, the variation for a few of them being as much as 3 in.

### CONCRETE PILES UNDER MACHINERY

For the machinery foundations, it was decided to use reinforced concrete piles, which did not require close spacing. In order to insure against uneven settlement and against vibrations due to the machinery, the load was limited to from 25 to 30 tons per pile for piles varying in length from 30 to 60 ft., the short-length piles being used under the slabs located considerably below the grade. It has been a great satisfaction to the owners, engineers, and contractors that, after two years of service, no settlement has been observed in any instance.

### USE OF HIGH, EARLY STRENGTH CEMENT

For caissons of the open-well type, the use of a good grade of high, early strength cement would mean a saving in time and cost in spite of its somewhat higher cost per barrel. Were it not for the fact that, in this instance, the owners had only a very limited supply at hand, which was manufactured at their Standard Portland Cement Plant, the high, early strength cement would have been used in the silo caissons as well as in the chimney caisson.

This type of concrete caisson is well adapted for large concentrated loads where the load concentrations can be placed directly on top of the caisson. For silo structures, such as those previously described, where a silo weighing 4,075 tons and covering an area of 870 sq. ft. is carried on four caissons, the use of concrete girders between the tops of the caissons and the silo walls makes a formidable girder structure.

To offset the expense of this girder construction, the advantage of operating a large sized clamshell bucket within a concrete caisson as against manual excavation in the smaller diameter of the steel-shell caissons should be considered. Moreover, the open-well concrete caisson, after it has served the purpose of reaching a firm bottom, is good for a large share of the ultimate load to be carried to rock or hardpan. The cost of sinking open-well caissons in clay soils will undoubtedly be lessened as the rotary excavator, which has been tried out in this district, becomes perfected.

SILO FOUNDATION CAISSONS
Shell Forms and Concrete Blocks for Weighing

# Designing State Highway Systems

*A Rational, Scientific Method Applied to Missouri Conditions*

*By* T. H. Cutler

Chief Engineer, Missouri State Highway Department

*THE Highway Division of the Society, which met at St. Louis on October 3, was fortunate in hearing Mr. Cutler's explanation of the Missouri method of designing the highway system of that State. The users of the roads bear the major expense of them. Highway systems should, therefore, be planned to facilitate transportation, and the roads designed to fit the traffic. Mr. Cutler has discovered a remarkably definite relationship between traffic density per capita and population per square mile, which he has used to determine the economic limitation to the building of the "marginal mile" of highway.*

MILLIONS of dollars have already been invested in Missouri's State highway system, and millions more will be spent on it in the future. An increasing percentage of this annual investment is carried by the motor vehicle owners through their license fees and gasoline taxes. In 1923, the sum collected in this way from owners of motor vehicles amounted to 24 per cent of the total annual investment; by 1928, it had increased to 44 per cent; and by the end of 1930 it will probably exceed 52 per cent. This shows the trend of present-day road financing.

In many States, such as Missouri, a major portion of the burden of State highway improvement falls directly upon the users of the roads and there is much justification for this, because they receive the first and principal benefits. Under these conditions the main purpose of highway development should be to serve them in the largest measure. Through failure to keep in mind and adhere to this main purpose of highway building, and from lack of economic criteria, State highway systems, or parts of them, have at times been laid out to satisfy communities, political factions, or pet notions of influential citizens. There is too much at stake to warrant such an illogical procedure. Even community development and social betterment are incidental to this service.

Highways, as well as motor vehicles, are a part of the transportation machine; neither part can function without the other. This machine serves an economic purpose, that is, it satisfies a human want. In order that it may serve most effectively, roads must be designed to suit the traffic, where the traffic wants to go. In other words, the component parts of the machine must be so adjusted that the greatest collective satisfaction will result at a given cost. This is the objective, the basic principle that should govern the design of a highway system.

### BASIS FOR DESIGNING A SYSTEM

At the outset of our study, a distinction should be made between designing a highway system and designing a highway. In the former, we are not very much concerned with the technic of road building, or with questions of line and grade, balanced quantities, and strength of slab. We are, however, concerned most intimately with the selection of routes and the type of surfacing, the service that they will render, the measure of that service, and the limitation that must be placed on total mileage. It is thus seen that the scientific selection of routes for the purpose of forming an economic and unified system is more fundamental than, and must take precedence over, the technic of road building.

There must be a basis for such choice; a reason must be given why certain existing routes shall be included in the State system and others shall not, why new roads should be built and old ones abandoned. These questions have a fundamental economic import; their answers are foreshadowed in the basic principle of maximum service for a given cost.

In the selection of routes, the general principle involved is that of rendering, at each step of the selection, the greatest service to the road users. A method for measuring this service is needed in order that comparisons between routes may be readily made.

### COMPUTING SERVICE TO USERS

The service rendered to the user of the road is that of dependability and economy. Dependability is measured by the number of days in the year that the road is in good, usable condition. Economy is measured in terms of saving in the cost of operating the motor vehicle. The total service rendered by a particular stretch of road is the aggregate of the service rendered to the individuals. Roads that are extensively traveled, other factors being equal, render a greater service than those not so frequently used. In other words, the greater the traffic density, the greater the service rendered by the particular road.

Density of traffic can be readily ascertained by means of a traffic census. This has been frequently done and results have been plotted on maps so that the observer can readily see where the density of traffic is great and where it is small.

An examination of such maps makes it clear that the greater traffic densities occur around the larger population centers. This fact indicates that there is some relationship between density of population and density of traffic. It would seem worth while to study this phase in order to ascertain accurately what that relationship may be. Some preliminary investigations indicate that in Missouri, at the present time, the traffic density per capita varies, as seen in Fig. 1, approximately inversely as the density of population. However, Missouri does not furnish enough communities of large size to establish this relation accurately. It is hoped that it will be studied by others who are in position to do so, in order that a general statement may be formu-

lated that will be fairly applicable throughout large sections of the country. With such a formula available, it becomes possible, knowing the population of the given series of cities and towns, to estimate the probable traffic that will result from the building of a selected road.

Density of traffic is also affected by the type of surfacing; a higher type inducing more travel than a lower type, even though the latter offers less mileage. This means that, in making a comparison of traffic densities for different population centers, the type of surfacing should be the same, or a corrective factor should be applied to compensate for the dissimilarity.

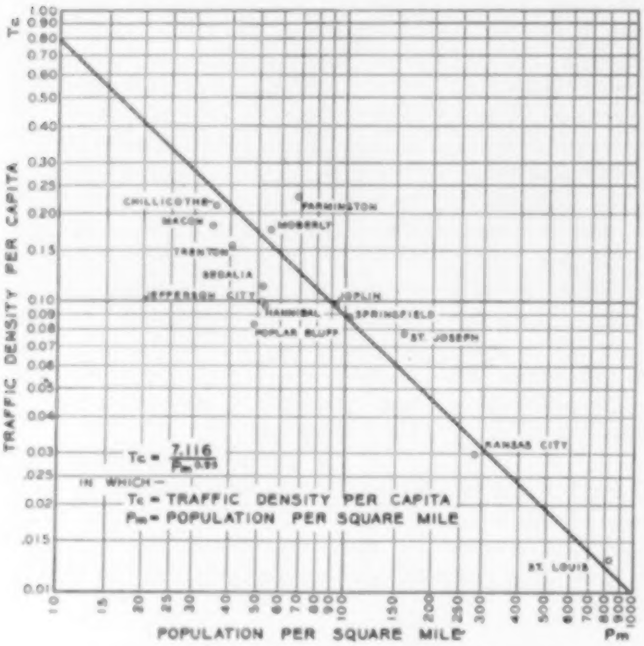



FIG. 1. TRAFFIC-POPULATION DENSITY CURVE

As first stated, the more traffic the road carries the more it serves the road users. This traffic, in turn, is a function of the density of population in the various centers along the road and hence the effectiveness of the road can be measured in terms of average population per mile of length. With this in mind, we begin our selection of roads for the State system by connecting the larger population centers that are close together. The shorter we can make this road and still serve a given number of population centers, the more population per mile is benefited. To determine whether or not a particular road should be added to the system, it is sufficient to determine whether or not it will serve a larger increment of population than some other road of similar length. This may be done by comparing the average rate of population per mile for each road.

As an illustration of this process of successive selection, a table has been prepared to show how such a process would apply to the Missouri State Highway System. The relative value of the several groups of roads is measured by the population per mile. Figure 2 presents this in graphic form. The lower groups combined, containing a relatively small percentage of total mileage, serve a large percentage of the population. This relation is shown in Fig. 3.

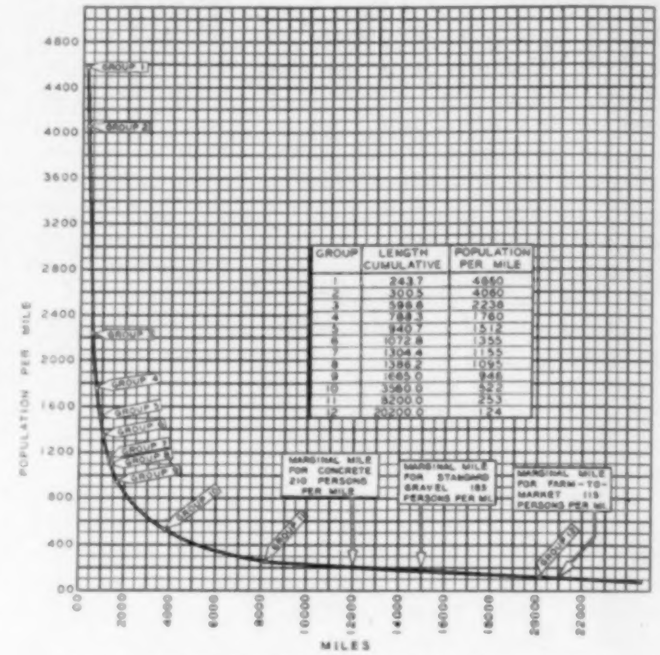



FIG. 2. EFFICIENCY OF ROAD GROUPS IN RELATION TO POPULATION DENSITY

## THE MARGINAL MILE

In this process of successive choosing, it is found at each successive step of road selection that there are fewer persons served per mile of length. It therefore becomes important to determine at what point the selection of routes should be stopped and a limit set to the mileage in the State system.

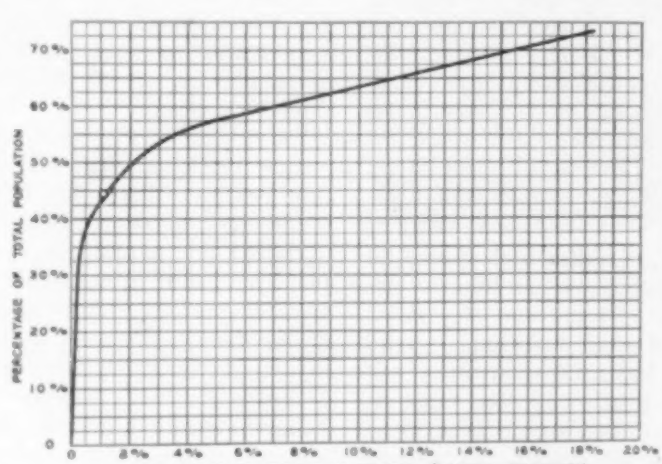



FIG. 3. PER CENT OF POPULATION SERVED IN TERMS OF PER CENT OF TOTAL ROAD MILEAGE

Recourse is now had to the economic principle of the "marginal unit." This means that the marginal mile of the highway system is such a mile that its annual cost balances the annual saving to the users of that particular mile.

Investigations have proceeded far enough and sufficient experience has been accumulated to enable us to set a quite definite limit upon the saving in cost of operation produced by an improved

road. We are thus able to compute the saving to the individual user and the probable amount of traffic, so that we can estimate the annual saving for any particular road. The annual cost is made up of the three cost items, interest on the construction cost, annual cost of maintenance, and annual cost of amortization. We now have sufficient data to determine the marginal mile and thus set a mileage limit upon the State system.

NEAR GINGER BLUE ON ROUTE 71
Indian Creek

CONCRETE HIGHWAY IN COLE COUNTY
Route 50, Near Jefferson City

Again, for purposes of illustration, this principle of the marginal mile is applied to the Missouri State Highway System. Let us consider a concrete road costing \$35,000 a mile for grading, culverts, and slab. The interest on this investment, at $4^1/_2$ per cent, is \$1,575. The annual cost of maintenance under heavy traffic will run about \$450 per mile. The amortization charge may be approximated by assuming that during a 25-year period the slab deteriorates and loses half its value, becoming suitable only as a base for new surfacing. On this assumption, the cost of amortization is equal to \$700 a year. Adding these three annual costs, we have for the total annual cost of this mile of road \$2,725. Now according to our basic principle, this slab must produce an annual saving, to road users, equal to \$2,725.

Since a concrete road will effect a saving of 2.6 cents per ton-mile over the ordinary dirt road, it would require 104,808 ton-miles of transportation in one year's time to produce an annual saving of \$2,725. It is conceivable that the average person within reach of this road would have occasion to use it 250 times out of the year, or 500 times going and coming. It would thus require 210 users to produce sufficient transportation to justify the building of the slab. This defines the point of economic extension for the concrete type of road in Missouri. As shown on Fig. 2, the marginal mile for concrete is reached when the total mileage of the system approximates 12,000. A similar process of reasoning, with proper changes in the cost data, indicates that the limit of economic extension for the gravel road is reached when 185 persons per mile make use of it. The marginal mile is attained when the total mileage of the system reaches 15,000. These margins will change, of course, as the population of the State changes, or as the per capita use of the highways changes.

### MEASURING THE EFFECTIVENESS OF THE SYSTEM

Having outlined the development of the State system by the process of successive selection, and having determined the allowable total mileage in the system by ascertaining the marginal mile, a measure for the effectiveness of the system as a whole must next be sought.

It is conceded that the ideal system would serve 100 per cent of the population and would therefore be 100 per cent effective. Hence, the effectiveness of any actual system can be readily stated in terms of the percentage of the total population served. In determining the population served, it is of course essential that the population of all the cities and towns along the route be included and also the intermediate population between such cities and towns adjacent or close to it.

The Missouri State highway system, with its 7,600

TABLE I. SUCCESSIVE HIGHWAY SELECTION, MISSOURI STATE HIGHWAYS

| | Group Units | Routes | Increment to Length in Miles | Per Cent of Total Roads | Increment to Population | Per Cent of Total Population | Population per Mile | Cumulative Length | Cumulative Per Cent of Mileage | Cumulative Population | Cumulative Per Cent | Population per Mile |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | St. Louis to Kansas City | 40 | 243.7 | 0.220 | 1,135,605 | 33.36 | 4,660 | 243.7 | 0.220 | 1,135,605 | 33.36 | 4,660 |
| 2. | Kansas City to St. Joseph | 71 | 56.8 | 0.051 | 81,145 | 2.38 | 1,428 | 300.5 | 0.271 | 1,216,750 | 35.74 | 4,060 |
| 3. | St. Louis, Springfield, Joplin | 66 | 296.1 | 0.268 | 115,670 | 3.40 | 391 | 596.6 | 0.539 | 1,332,420 | 39.14 | 2,238 |
| 4. | St. Joseph to Hannibal | 36 | 191.7 | 0.173 | 56,751 | 1.67 | 296 | 788.3 | 0.712 | 1,389,171 | 40.81 | 1,760 |
| 5. | Marshall to Springfield | 65 | 152.4 | 0.138 | 34,286 | 1.01 | 225 | 940.7 | 0.850 | 1,423,457 | 41.82 | 1,512 |
| 6. | Moberly to Rolla | 63 | 132.1 | 0.120 | 34,766 | 1.02 | 263 | 1,072.8 | 0.970 | 1,458,223 | 42.84 | 1,355 |
| 7. | St. Louis to Caruthersville | 61 | 231.6 | 0.210 | 51,460 | 1.51 | 222 | 1,304.4 | 1.180 | 1,509,683 | 44.35 | 1,155 |
| 8. | Hannibal to Wentzville | 61 | 81.8 | 0.074 | 7,859 | 0.23 | 96 | 1,386.2 | 1.254 | 1,517,542 | 44.58 | 1,095 |
| 9. | Remainder of primary system | — | 278.8 | 0.252 | 57,452 | 1.69 | 206 | 1,665.0 | 1.506 | 1,574,994 | 46.27 | 946 |
| 10. | Remainder of National system | — | 1,895.0 | 1.715 | 282,846 | 8.31 | 149 | 3,560.0 | 3.221 | 1,857,840 | 54.58 | 522 |
| 11. | Remainder of enlarged State system | — | 4,640.0 | 4.199 | 213,267 | 6.26 | 46 | 8,200.0 | 7.420 | 2,071,107 | 60.84 | 253 |
| 12. | Supplementary system | — | 12,000.0 | 10.860 | 437,061 | 12.83 | 36 | 20,200.0 | 18.280 | 2,508,123 | 73.67 | 124 |

NOTE: Total mileage of enlarged State system = 8,200; total mileage of supplementary system = 12,000; total mileage of all roads in State = 110,500.

miles, as originally designated in the Centennial Road Law of 1921, serves 60.84 per cent of the State's population. That part of the system designated as Federal highways and having a length of 3,560 miles, serves 54.52 per cent. That part set aside as primary roads to connect the larger population centers, and having a traveled distance of 1,660 miles, serves 46.27 per cent, while the three routes connecting St. Louis, Kansas City, and Joplin, 694 miles of distance, serve 37.18 per cent. The main thoroughfare, constituting the backbone of the system, connecting Kansas City and St. Louis, and having a traveled distance between city limits of 244 miles, serves 33.36 per cent of the State's population. It is thus readily seen that the more effective roads in Missouri are those connecting large population centers.

LARGE RADIUS CURVES AT INTERSECTION
Crossing of Routes 65 and 40

A ROAD SCENE NEAR NOEL, MCDONALD COUNTY
Route 71

We now have under way the construction of a State supplementary system, popularly known as the farm-to-market system, which eventually will embrace about 12,000 miles, and will serve an increment of population amounting to 12.83 per cent. The total population that can be served by the State system plus the supplementary roads, the whole embracing nearly 20,000 miles, will be 73.67 per cent. Present calculations indicate that the so-called marginal mile for Missouri is reached at this point.

As previously stated, the economy of a road is expressed in terms of the saving in operation costs to the users. The aggregate of such savings over a period of time divided by the number of users, or motor vehicle owners, would give us the average saving per vehicle as a measure of the economy of the system. This measure is useful in comparing various systems or in determining the justifiable expenditure for the building system.

Through a long series of tests, largely conducted in Iowa, it has been ascertained that a first-class, improved concrete road will save, in cost of operation, 2.6 cents per ton-mile more than an ordinary dirt road. Likewise, the saving on a good gravel road, as compared with the ordinary dirt road, is 1.6 cents per ton-mile. Having estimated the amount of probable traffic per annum, it is possible to say what the total savings will be for a given amount of traffic and whether or not they are sufficient to justify an investment in the system. The aggregate of these annual savings must be enough to balance the annual cost incurred by building the system, in order that its construction may be justified.

Closely associated with the annual saving produced by improved roads is the matter of choosing a proper method for financing the construction of the system. If the increment to the annual saving due to expediting the construction of the system is more than sufficient to pay the interest on a bond issue, then such bond issue effects a true economy. On the other hand, should the accelerated program fail to produce an increase in annual savings over that produced by the pay-as-you-go plan, then a bond issue would not be good economy. Whether or not bonds should be issued depends upon the increment to the annual savings that a corresponding acceleration in road construction progress would produce.

## CONCLUSION

Finally, I wish to emphasize the two dominant ideas involved in the designing of State highway systems. The first idea is that of the successive selection of routes in such a way that, at each step of the process, each succeeding increment of mileage serves, in its turn, the largest percentage of road users. Such a process leads to a diminishing percentage of users served.

The second idea is that of the marginal mile. It is seen that, with a diminishing percentage of road users served by each succeeding increment of mileage, there must be a limit to mileage beyond which it is uneconomic to go. That limit is defined by the marginal mile, which is the mile having an annual cost equaling the annual savings in operation costs to the road users.

Undoubtedly this marginal mile has been shifting outward during the past ten years, for there has been a large increase in improved road mileage and also some increase in population. The increase in improved mileage has caused a larger per capita use of the highways, as evidenced by the increasing consumption of gasoline per vehicle as well as the rapidly increasing registration of motor vehicles. This shifting of the marginal mile outward signifies that a larger mileage within the State system would be economically justified. This, in turn, indicates that the Federal aid system should be enlarged to meet the fundamental change that has taken place. Instead of Federal aid being restricted to 7 per cent of a State's total mileage, it should be increased to 10 or 12 per cent perhaps. This is a matter of sufficient importance to be taken up in a separate investigation.

# Factors in Selecting County Highways

*Establishing the Regional Plan and Financing Its Construction*

*By* Roy W. Jablonsky

Associate Member American Society of Civil Engineers
County Surveyor and Highway Engineer, St. Louis County, Clayton, Mo.

*TRAILS established by wild animals, followed by Indians, and used by the early pioneers have often developed into the present-day thoroughfares, sometimes to the detriment of efficient operation of modern high-speed transportation facilities. Mr. Jablonsky's experience with the highways of St. Louis County qualifies him to speak on the subject of selecting, from the maze of transformed trails, those which should become a part of a complete county highway system. This is an abstract of his paper, presented October 2, 1930, before the Highway Division, at the Society's Fall Meeting in St. Louis.*

EXISTING highways throughout the country are to a large extent the original trails established by the pioneers of earlier days. The fact that these trails were the nucleus of the present highway systems and major street plans of most cities and counties is borne out by the early records of St. Louis. The present United States Route 40 follows St. Charles Road in St. Louis County, over what was known in the earlier days as Owens Station Road.

As the trend of development followed these old routes, it became necessary to improve them, thus establishing them as main arteries of travel. The advent of the motor conveyance has shown the impracticability of using them in their entirety as major highways, and it is now the problem of public administrative departments, especially of counties, to perfect plans for a unified and correlated system of highways best serving the interests of the public.

There are many important considerations involved in designing an adequate county highway system, which can be classified under the following heads: necessity; arrangement and character of highways; legislation for planning; and financing the construction.

MORE HIGHWAYS NEEDED

In analyzing these four principles in the order given, under the first head would be classified congestion relief, directness and time saving, and the economic development of property. The change in transportation from horse to motor vehicles has increased the amount of traffic to such an extent that highways serviceable in pre-motor days can no longer be recognized, and traffic relief routes must be established. While some other mode of travel may supplant the motor vehicle, a new form of transportation will not obviate the necessity for economical transportation means. Air transport of freight and passengers may become the principal means of transportation in the future, but surface transportation will always exist, as it has since the beginning of history.

Estimating the requirements of future highways requires superhuman foresight. For example, railroad locations are now being revised, permitting greater hauling capacity over the same two rails. Past errors were probably due more to ignorance of future traffic requirements than to poor engineering, as railroads were constructed to develop the traffic and the engineer of that date could not foresee the trend of development. It is probable that future generations may claim shortsightedness on the part of the present generation, should some new method of transportation supplant motor-vehicle movement.

In establishing these routes, full consideration must be given to directness and the speed with which highway traffic can move from one point to another, speed being synonymous with time. Highway construction in the past has not kept pace with the increase in traffic, and the larger volume of traffic between population centers now necessitates direct and wider routes.

The location of subdivided areas is generally along old established routes, both highway and transit, and usually no thought has been given to the future development of an area larger than the tract of land subdivided.

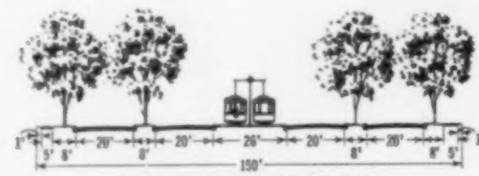
Developed areas demand better traffic facilities while undeveloped ones, which will be the future communities, must be given consideration and proper highway locations. All parts of the county


Fig. 1. Highway System for St. Louis City and County
Proposed by Bartholomew and Mills, City Plan Engineers

should have equal accessibility, as future growth will follow highway locations as it has in the past. Political boundaries, as of incorporated towns, should be disregarded and the county considered as a unit.

### CHOOSING THE ROUTES AND ESTABLISHING THEIR CHARACTER

In determining the particular system and type of highway to be adopted to provide adequate transportation facilities, a study of the following should be made: dominant traffic routes, primary routes, major highways, local district highways, width of rights-of-way, and construction standards. Typical cross sections of highways proposed by Bartholomew and Associates are here reproduced.



Final Stage with Rapid Transit Facilities

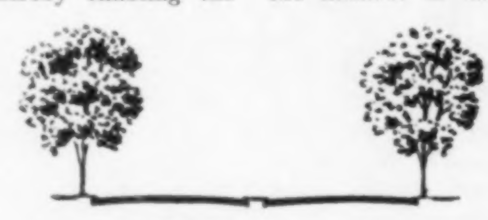
DOMINANT RADIAL HIGHWAY
Proposed for St. Louis County

Dominant traffic routes, providing for future rapid transit facilities, must be planned to accommodate ultimate traffic movements. Such routes should extend to all parts of the county in such a manner as to insure growth in all directions from the thickly populated areas. They are what might be termed super-highways, having grade separations at intersecting major highways as well as at railroads, and might properly be in the State highway system.

Primary routes having no rapid transit facilities should be planned and located so as to serve that part of the county not touched by the dominant traffic routes; they should have the advantages of directness and continuity.

Major highways are those which will carry the large volumes of traffic distributed from the dominant and primary routes, and which will afford movement to all parts of the county, connecting communities and population centers. It is along these routes that developments will take place, thereby creating a network of rural district highways and residential streets.

Local district highways are those that connect with the major highways. They are probably far more important to the individual residents of the county than any of those previously mentioned. The influence gained by their location and construction is an important factor in carrying bond issues, thereby enabling the establishment and construction of county highway systems.



Initial Stage without Rapid Transit

Final Stage with Rapid Transit

SUPPLEMENTARY RADIAL HIGHWAYS
Proposed for St. Louis County

### DETERMINATION OF RIGHTS-OF-WAY

In planning a county highway system, right-of-way widths should be determined to adequately relieve congestion, and they should be based on the assumption that traffic will materially increase. It is difficult to determine the extent of traffic increase, but probably it is safe to assume that motor transportation will be the main means of travel for at least 25 or 30 years. A knowledge of present requirements and of the trend of future development and engineering features should enable a fairly close estimate of this increase to be obtained.

In such a study, the following minimum widths for rights-of-way should be established, increasing where necessary owing to topographical features.

| | |
|---|---|
| Dominant traffic routes | 150 ft. |
| Primary routes | 100 ft. |
| Major highways | 80 ft. |
| Local district highways | 60 ft. |

These widths will provide eventually for the necessary traffic lanes.

Dominant traffic routes of 150 ft. can be eventually developed to permit space for:

| | |
|---|---|
| Rapid transit in center | 26 ft. |
| Express highways on each side of rapid transit, two 20-ft. pavements | 40 ft. |
| Local traffic on each side of express highways, two 20-ft. pavements | 40 ft. |
| Two 8-ft. strips to separate express and local lanes | 16 ft. |
| Two 14-ft. sidewalk and planting strips | 28 ft. |
| Total minimum width | 150 ft. |

Primary routes of 100 ft. will provide for the eventual development of six active traffic lanes and two parking lanes, or a total of 72 ft. of pavement, the balance being used for planting strips and sidewalks.

Major highways of a width of 80 ft. will provide four active traffic lanes and two parking lanes, with the balance left for planting and sidewalks.

Local district highways should be not less than 60 ft. wide, which will provide two active traffic lanes and two parking lanes, and 24 ft. for planting and sidewalks.

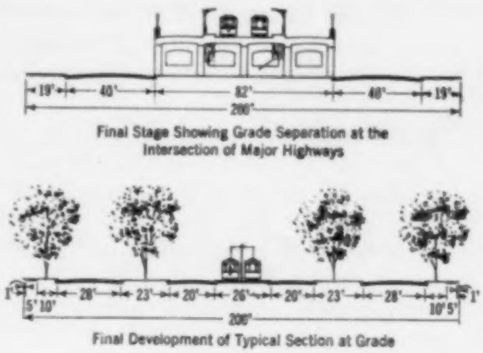
The widths of traffic lanes are based upon the widths and types of vehicles permitted by the present laws, and these widths can be used for future planning. While freight transportation and passenger service may increase a great deal, it is difficult to believe that increased size will be permitted, as the tendency now is to reduce the length and width of motor vehicles.

The chief obligation of administrative departments is to provide adequate widths which will be available when traffic has increased to such an extent as to demand the number of traffic lanes suggested. Construction standards have changed with the methods of transportation and it is now the duty of engineers to secure better locations, easier curves, flatter grades and to develop a highway which is safe for traffic, considering the speed of modern vehicles and its effect on road surfaces.

The type of pavement best adapted to one location may not be successful in another, as climatic and topographical conditions are governing factors. Special studies should be made for each location. However, in passing, it might be said that a pavement requiring very little maintenance is the most economical even though the

original cost may be greater.

Planning and executing a comprehensive highway system are functions which should be reposed in a body commissioned by appropriate legislation for those purposes only. The ultimate development of a community cannot be visualized without an enduring plan, a plan that cannot be cast aside and ignored because of personal aversion or political obligations. Without a planning commission clothed with authority to perpetuate this plan and restrict the use of potential highway allocations, it would be short lived and its purposes defeated. As few States at the present time have planning legislation, it is necessary in discussing highway development to consider this important matter.




Express Highway, 200 Ft. Wide
Proposed for St. Louis County

PLANNING ACT DRAFTED

President Hoover, while Secretary of Commerce in the Harding Cabinet, called together a body of planning consultants for the purpose of drafting a model planning act. This act provided for establishing a planning commission and defining its powers and has been used as a guide by legislators in most of the States that have since enacted planning legislation. Immediate steps should be taken to secure planning legislation in all states, as any delay will render the practicable and economical location of potential highway areas more difficult.

FINANCING THE CONSTRUCTION

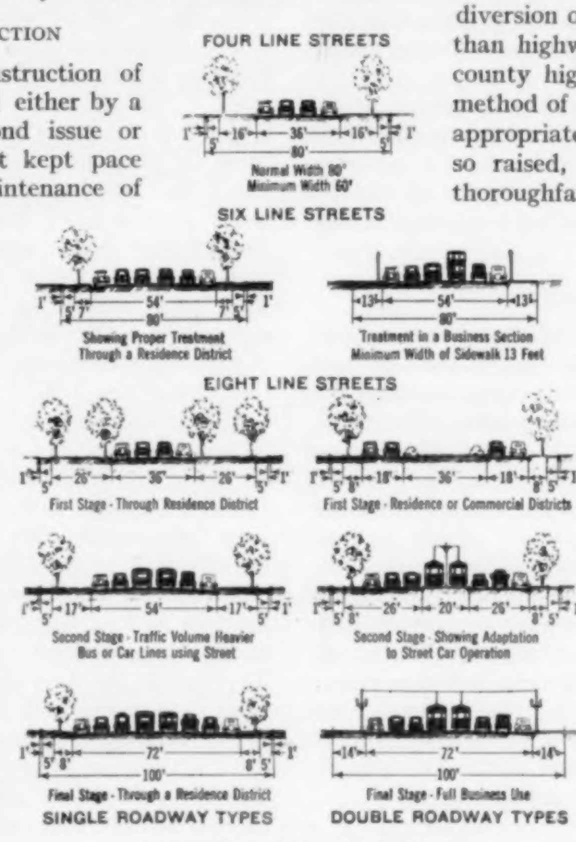
The establishment and construction of county highways are financed either by a direct property tax or by bond issue or both. A county that has not kept pace with traffic increase finds maintenance of existing highways beyond the income from taxes permitted to be levied for that purpose, leaving nothing for new construction. It is possible for a county to be "road poor." This situation is relieved somewhat by State highway improvements financed by a general tax on gasoline and auto registration. However, the mileage of State highways allocated for each county is small compared with the total mileage of the county highways. In such case, abandonment of unnecessary highways should take place.

County bond issues have been resorted to, thereby placing the entire burden on real and personal property within the limits of the particular county voting the bonds. Owners of property along improved highways no doubt receive a direct benefit in increased valuation of property as well as an indirect benefit by being placed in contact with other communities. If bond issues should continue to run for a longer period than the life of the highway improvement, replacement issues necessitated by increased traffic would eventually overbond the county without obtaining an ideal highway system. This condition will be prevented if bonds for highway construction are issued to run for a period not to exceed the life of the construction.

CAR OWNERS SHOULD PAY PART

It therefore seems reasonable to assume that motor vehicle owners will be called upon to meet a part of the cost of improving highways incorporated in a county highway system. This may appear unfair to the motor owners, when it is remembered that, in the past, millions of dollars were spent to improve the original trails for horse-drawn traffic with no tax other than one on personal property. However, the motor has so changed highway structures that a division of the investment between owners of property and motor car owners seems fairer.

The gasoline tax method of raising funds for highway construction is as near painless a method as has been devised. Care must be taken, however, to prevent the diversion of funds so collected to other uses than highway purposes. But, in order for county highway systems to benefit by this method of raising funds, legislators should appropriate generous amounts of the funds so raised, for the improvement of county thoroughfares.




Major Street Cross Sections
From the Plans Submitted by Bartholomew and Associates

LEGISLATION SHOULD PROVIDE REGIONAL PLAN

Briefly summarizing, counties, especially those having thickly populated areas, should have a highway plan, designed to control the development of highways so that the county and environs may be served practically, adequately, and efficiently. To this end appropriate legislation should be secured providing for the development and financing of the plan. The necessity for highways being apparent under modern traffic conditions, it becomes the business of public administrative departments to develop a coordinated and efficient, rather than a haphazard and inefficient system.

# Twelve-Month Construction

*Economic Advantages and Practical Methods of Conducting Winter Work*

*By* JAMES S. TAYLOR
CHIEF, DIVISION OF BUILDING AND HOUSING
BUREAU OF STANDARDS, DEPARTMENT OF COMMERCE

*FEW aspects of the construction industry are of greater importance than so planning the work that construction may continue all the year round. This results in a more uniform labor supply and a better material market. Twelve-month construction, however, requires working against adverse cold-weather conditions. Mr. Taylor's paper, which was presented before the Construction Division of the Society at the St. Louis Convention in October 1930, ably surveys the economic advantages and methods for the successful conducting of winter construction work.*

DURING the last decade winter construction has greatly increased as compared with the period before the World War. There are various underlying causes for the change. First, pre-War experience with winter construction was greatly multiplied by war-time undertakings, which made the industry and the public become more familiar with the idea.

Second, twelve-month construction of many types has a sound economic foundation, as there are often large savings for the owner, and for practically every group connected with construction, in early completion or more appropriate planning of the work. Engineers, architects, contractors, building-material manufacturers and dealers, transportation agencies, and building-trades labor gain through steadier operations throughout the year. The larger organization and greater investment in plant and equipment now required for building operations tend to increase carrying charges during dull periods and thus make stabilization of greater importance to engineering and contracting organizations.

Third, the problem affects so large a section of the community that it is of importance to many other lines of business as well as to the public generally, and this fact has strengthened a number of efforts to foster a nation-wide movement to encourage seasonal stabilization.

### EDUCATING THE PUBLIC

While the technical problems of winter construction in various types of operations are important, the fact-finding and educational side of distributing construction more evenly throughout the year is also of great importance. Building owners, public-works officials, and others responsible for starting construction or for having repairs and maintenance carried on require education concerning what can be accomplished. There is much room for local effort on the part of building congresses—such as those in New York, Philadelphia, Boston, and Portland, Ore.—to impress owners and contractors alike with their responsibility for furnishing more stable employment. Furthermore, the buying power of workmen who are steadily employed helps to make business. But the best propaganda is possible when the construction industry unites with other groups to present seasonal stabilization as a matter of broad public concern.

The work of the Committee on Seasonal Operation in the Construction Industries, which was appointed by Mr. Hoover in 1923 and made its report in 1924, illustrates this point. The conclusion of the report with its statement that "custom, not climate, is mainly responsible for seasonal idleness in the construction industry" caught the public imagination. This conclusion was based on the survey made for the committee by the Division of Building and Housing. Data furnished by the Weather Bureau offered a clear view of average winter conditions throughout the country. Government weather reports, covering a considerable period and showing normal January conditions, indicate (Fig. 1) that, in a large portion of the country, relatively slight precautions are necessary in order to protect building materials ordinarily used in construction and to insure comfort for workmen. It appears that the average man tends to exaggerate the seriousness of cold weather in its effect upon construction.

### ACTUAL WEATHER CONDITIONS STUDIED

Therefore, advice was sought from a number of practical builders and labor leaders as to what temperature and how much precipitation slow down or stop outdoor work. The amount of precipitation fixed upon was 0.05 in. of water per hour, whether in the form of rain, snow, or sleet, and the effects of temperature were divided into three classes, depending on severity. Relatively mild weather was designated as between 25 deg. and 32 deg. Next came those days when the temperature did not go below 18 deg. but rose above 25 deg. at some time during the day. Really cold weather was designated as that in which the temperature fell below 18 deg. at some time and did not rise above 24 deg. at any time during the day.

Using this method of measurement, a study of weather records in nine cities was made over a period extending back for ten years. The cities studied were St. Paul, Denver, Chicago, Boston, New York, St. Louis, Atlanta, New Orleans, and San Francisco. St. Louis was found to have an average of 11.1 days during the year in which outside work was prevented by precipitation. It had a total of 14.9 of the coldest days mentioned, 12 of the middle classification, and 29.3 of the mildest type. Accordingly the days during which complete stoppage of work is to be expected in this city are relatively few.

The relative distribution of the three classes of cold days in Chicago, as well as the record for precipitation in that city, is shown graphically in Fig. 2. With such records before them, contractors and owners in each city could approach the problem of winter construction with a much better idea of the prospective difficulties and

costs than can be gained by any purely subjective impression of weather conditions.

### OTHER SEASONAL VARIANTS

The custom of having only one or two leasing dates throughout the year tends to bring about congestion in construction activities in various cities, and also to create a serious problem for electricity, gas, water, and telephone companies.

A very acute condition is caused by demands of telephone subscribers in Richmond, Va., because September 1 is the leasing date prevailing in that city. The number of telephones moved from one place to another on September 1 is over six times greater than the average for the remainder of the year. If such facts were more widely known and the consequences appreciated, the public, no doubt, would look more favorably upon a change in its local conditions.

The decided seasonal trend of labor employment is apparent from a study of Fig. 3, which shows the seasonal fluctuations in labor payrolls and in purchases of building materials in the case of contractors in 25 cities.

The committee proposed the use of a type of chart showing by months the relative degree of employment of eight different building trades. By superimposing the period necessary for each trade to do its work in proper sequence upon these lines and by shifting these lines back and forth over the chart, it was shown how a starting date, advantageous from a labor standpoint, could be selected. Such a chart, Fig. 4, is shown for a particular building in Boston, the time indicated for starting operations having been selected from the standpoint of having a plentiful labor supply available throughout the period of the work. The chart can be made applicable to any city by first studying the local fluctuations in labor employment and then recording them graphically as indicated.

Certain operations, such as the paving of roads during rainy seasons or while there is frost in the ground, are not now considered suitable for winter work. But there

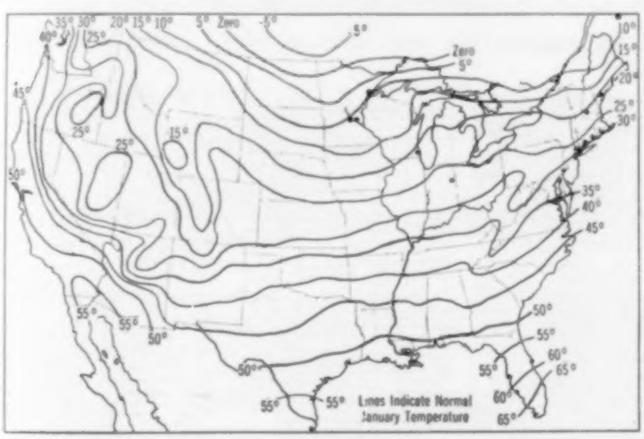



Fig. 1. Isothermal Chart of Normal January Temperature

is still room for the further development of improved methods for winter work in many fields.

### ARGUMENTS ANSWERED

The chief arguments against winter work are the extra cost of protection and the reduced efficiency and production of labor and machinery. While the first is an actual cost, the other is, in a measure at least, controllable by the ingenuity of the engineer or contractor and by the employment of methods which experience has shown to be effective.

As has been indicated, the picture of winter severity is

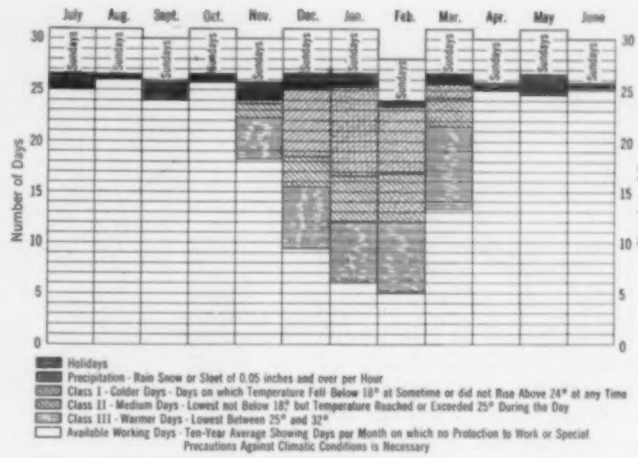



Fig. 2. Weather Conditions Affecting Outdoor Construction—Chicago, Ill., 1913–1923

generally overdrawn. Severe weather usually comes in comparatively short spells, the balance of the season consisting of fine weather of more moderate temperatures. So production on a clear, snappy winter day may not suffer in comparison with that on a hot, sultry day in August. And with reasonable resourcefulness and initiative, working conditions can be made nearly as agreeable in winter as in summer.

The requirements for winter work differ from those of summer chiefly in the additional precautions for heating, housing, and protection of work in place. Then, the process, reduced to a routine nature, becomes one of getting materials to the job, if the project is isolated, preparing them for use, protecting the work in place while curing, and housing personnel and equipment incident to the work.

Transportation problems chiefly affect the isolated jobs. The city building operation gets its materials by truck delivery either from the railroad or from a building-material supply yard, so winter usually presents few difficulties in that respect; and even for the isolated project the advent of the tractor has robbed the season of many of its terrors, so the job which is forced to shut down because of transportation difficulties is becoming a rarity.

Preparing materials for use in cold weather is usually a problem of more importance because it is more often encountered. Through experience, a technic has been developed—whether with steel, concrete, brick, or other materials—that ensures a finished product undamaged by winter conditions.

### PROCESS FOR CONCRETE CONSTRUCTION

The process employed in the case of concrete construction consists usually of heating the fine and coarse aggregates, heating the mixing water, or heating both in combination, protecting stock piles for both masonry and

concrete work, and housing the materials affected by moisture, as well as the entire mixer and plant.

One of the principal requirements for concrete work is that the temperature of the concrete, when placed, shall be above 60 deg., and whether this is obtained by heating aggregate and water separately, or in combination, or

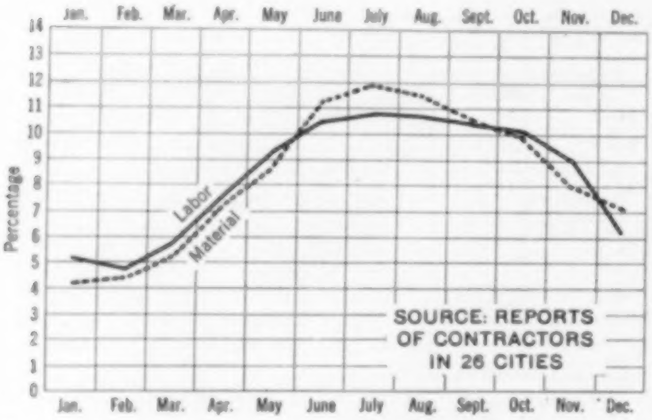



FIG. 3. MONTHLY VARIATIONS IN BUILDING MATERIAL PURCHASES AND IN EMPLOYMENT OF LABOR IN 25 CITIES

heating the water alone, is a matter for individual decision. Any method is acceptable so long as the desired result is obtained.

After the materials are prepared for use, the next step is to protect them from frost while placing and curing. This becomes of more importance in building operations than in bulk work, such as bridge and dam construction. The relatively smaller section of a concrete beam or column is more readily and seriously affected by freezing than is the larger mass of a bridge abutment or a section of a dam; and, in addition, the bulk concrete provides more heat in setting, and this heat is less easily dissipated from the larger mass.

Bulk concrete operations may be completely housed in and the interior temperature maintained at any required degree; and due to the volumes involved, the housing expense is a fairly small item. In building construction, however, it is not usually expedient to house in the entire building, although in a few cases this has been done. But it is entirely practicable to enclose with canvas the story being framed and possibly the story next below. Heat is then provided by devices of a suitable nature—usually salamanders—and the concrete pouring proceeds as at any other season. The required temperature, checked by thermometer readings, is maintained long enough to permit the concrete to secure its permanent set without harmful effects from frost action. Each story is treated in this manner until the building is completed. It is usually necessary to protect the slab after pouring, and this is done by covering it with canvas or straw, or both, and by leaving a few small openings in the slab permitting the heat from below to circulate over the top of it.

Because of the rapid and serious effects of frost on concrete, the use of this material demands special precautions. Masonry of other types, however, must also be protected during and after placing, and the same principles are applicable. The mortar materials should be heated and the masonry units kept dry and free from frost. For brickwork on small projects, heated sand may be provided fast enough to meet the demand by piling sand over a section of large-diameter smoke stack in which a hot wood fire is kept burning. In laying up brickwork, the wall should be enclosed and heat supplied. Heating devices are usually salamanders, although in some instances the small electric heater has also been successfully used. The enclosing of the walls is accomplished by the use of hanging scaffolds which are completely enclosed by canvas, and the interior of this housing is heated from devices on the scaffold.

### IMPORTANT FACTORS IN STEEL ERECTION

Steel erection seldom stops on account of cold weather, except when severely windy days make the hoisting of material hazardous, or the formation of ice on the steel in place makes it dangerous for the workmen. Of primary importance is the condition of the working deck, as a slip here is so likely to be fatal. It is essential, therefore, that the deck be kept clear of snow and ice and that the planking be tight and in good repair.

As the tiers of steel are not usually received on the job much in advance of erection, there is not the problem of protection of storage material as in the case of masonry and concrete materials. However, it is usually profitable to protect such piles of steel as may be present, since it is far easier to keep ice from coating the steel than it is to remove it after it has formed. Due to the high winds encountered during the winter months, it is important that connections during erection be adequately bolted to resist the wind stresses and that riveting follow the erection very closely. If this point is neglected, the steel frame may be twisted out of plumb, and the job of bringing a twisted frame back to its proper position is difficult and expensive.

With the skeleton and shell of the building completed, the interior finishing is comparatively simple and involves only the closing of openings and heating from a temporary or permanent hook-up of the heating system.

### SPECIAL WINTER HAZARDS

In construction work during winter months certain


FIG. 4. PLANNING CONSTRUCTION TO FIT LABOR SUPPLY

precautions, which are not of so much importance in summer work, must be observed. The heating of materials and work in place and the use of open fires introduces fire hazards which are absent during summer

months, and the effect of cold weather on fire-fighting facilities makes it more difficult to combat fires. For these reasons constant vigilance must be maintained, and watchmen and inspection services must be kept at a high standard.

Especial care has to be exercised in the stripping of forms and in reshoring because of the slower hardening of concrete. Frozen concrete must be removed when detected and snow and ice cleaned from the forms before pouring is started. Safe accessibility to working operations about the job must also be provided, and this includes the removal of snow and ice from walks, stairs, and ladders and the sanding of walks, stairs, and runways to prevent their becoming slippery and dangerous.

TYPICAL PROTECTION—WINTER CONCRETE CONSTRUCTION

Temporary water and air lines cause considerable annoyance and delays in cold weather through freezing. Low spots in these lines must be avoided and the lines, whenever possible, either packed in straw or buried below the frost line. Draining the lines at night will usually ensure a water supply for the morning work.

The ill effect of too rapid an application of heat to work in place is another factor of importance. Salamanders should be placed at a sufficient distance from fresh concrete to insure against too rapid or uneven drying and shrinkage of the concrete. The use of salamanders lowers the moisture content of the air, and this must be replaced from other sources.

Ventilation assumes more importance in winter because of enclosures. And salamanders—particularly coke-burning ones—may, in confined spaces, become injurious to workers unless fresh air is provided.

Plastering—especially near exterior openings—is likely to be affected by frost action and must be provided with sufficient heat to permit it to harden without being frozen. Plumbing lines, when under test, also require considerable care. However, the exercise of care and an intelligent use of thermometers will pay big dividends in winter work both in the structural and in the finishing parts of the project.

#### COSTS NOT EXCESSIVE

All these precautions are necessarily expensive, but analysis indicates that the extra amount is not excessive when considered in relationship to the advantages. Actual figures on the extra cost of providing protection and temporary heat for winter work are not so available as might be desired. From the data at hand, however, it appears that this extra cost ranges from 1 to 5 per cent of the total cost of the operation, decreasing as the size of the job increases. But, considering the operation as a whole and keeping in mind the interests of all concerned in the year-round program, this percentage of increase is often absorbed by the benefits resulting from release of tied-up capital, savings in labor cost from increased production and more efficient labor, closer bidding by contractors, and an earlier use or occupancy of the completed structure. So twelve-month construction has, all in all, proved its soundness and its right to united support.

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### THE MID-HUDSON BRIDGE

This toll link in the New York state highway system connecting Poughkeepsie with Highland, N.Y., was opened to traffic on August 25, 1930. It has a central span of 1,495 feet and its two side spans are 750 feet. A clearance of 135 feet above high water is provided for navigation.

Foundations for the 415 foot towers were reached 135 feet below high water. The cables, $16^3/_4$ inches diameter, 42 feet apart, contain 19 strands of 320 wires each.

Frederick S. Greene, Mem. Am. Soc. C.E., Supt. of Public Works. Modjeski and Moran, Mems. Am. Soc. C.E., Consulting Engineers. Scott Brothers Construction Co., anchorages; Blakeslee-Rollins Co., piers; American Bridge Company, superstructure.

# HINTS THAT HELP

*Today's Expedient—Tomorrow's Rule*

*The minutiae of every-day experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.*

## Cyclic Variations by Curve Reduction

*By* JESSE W. SHUMAN

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
SECRETARY-TREASURER, POWER ENGINEERING COMPANY
CONSULTING ENGINEERS, MINNEAPOLIS

DESPITE the bristling mathematics involved in some of the methods proposed for smoothing out curves plotted from natural phenomena, such as river run-off, rainfall, temperature, and other fluctuating data, the actual mechanical operation of the method here illustrated is quite simple.

When run-off records are available over a continuous period, it is important to discover the trend of the record—its cyclic variations, if any. This method is one that is used by many for that purpose.

In Table I is given, opposite the year, the average annual run-off of the Kaministiquia River in Ontario from 1908 to 1929, inclusive, and these data are plotted in Curve *a*, Fig. 1.

The sum of the run-off numerals in Col. 2, taken in consecutive pairs, is recorded in Col. 3, opposite the second figure of the pair; thus 1,378 sec-ft. for 1908 is added to 1,096 sec-ft. for 1909, and the total, 2,474, is written opposite the year 1909. Likewise the sum of the totals in Col. 3, taken in consecutive pairs, is recorded in Col. 4 opposite the second numeral of that pair; thus 2,474 opposite 1909 is added to 1,935 opposite 1910 and 4,409, the total, is recorded opposite 1910. These consecutive sum operations may be continued for three or more stages, or until the fluctuations are ironed out sufficiently to observe the trend. For this river, two appear sufficient.

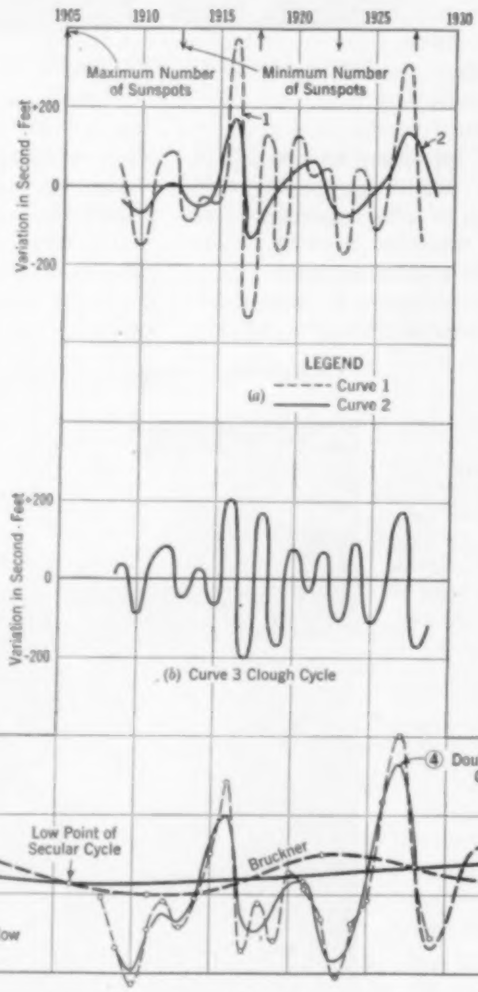
The numerals in Col. 4 are restored to scale and position by dividing by 4 and recording in Col. 5, opposite the previous year. Thus one-fourth of 4,409 is recorded in Col. 5 opposite 1909, and designated as *R*2.

The numerals in Col. 5 are then subtracted algebraically from the run-off numerals in Col. 2 to obtain the positive and negative values in Col. 6. The latter values are plotted in Fig. 1 (*a*). At the top of this diagram the vertical arrows indicate the years of maximum and minimum sun spots, those pointing upward being for the maximum and those pointing downward being for the minimum years of sun-spot activity. An examination of Curve 1 discloses peaks in 1912, 1916, 1920, and 1927, just prior to maximum and minimum sun-spot numbers.

A similar tentative plotting (not shown) of the values of *R*2, as restored to scale in Col. 5, shows similar peaks and the presence of the Double Wolf Cycle in the data. This Double Wolf Cycle is named after Prof. A. E. Douglass, of Tucson, Ariz., who first called attention to it in connection with his study of tree rings

Next trace through the center of the loops of Curve 1, the median line, *M*1, as shown, following as closely as possible the general contour of *R*2. Then record the ordinate values, plus and minus, in Col. 7 of the table. Subtracting *M*1 from *S*1 algebraically (Col. 8), and plotting Curve 3 from the data thus derived gives the Clough Cycle, as described in the *Monthly Weather Review*, Washington, D.C., September 1924. Adding *M*1 to *R*2 (Col. 5) furnishes the data to plot the Double Wolf Cycle, shown as the heavy line, Curve 4, that threads through the original run-off graph, Curve *a*. The algebraic sum of the ordinates of Curves 3 and 4 gives the original run-off data in Col. 1.

This record is too short to determine the longer cycles,



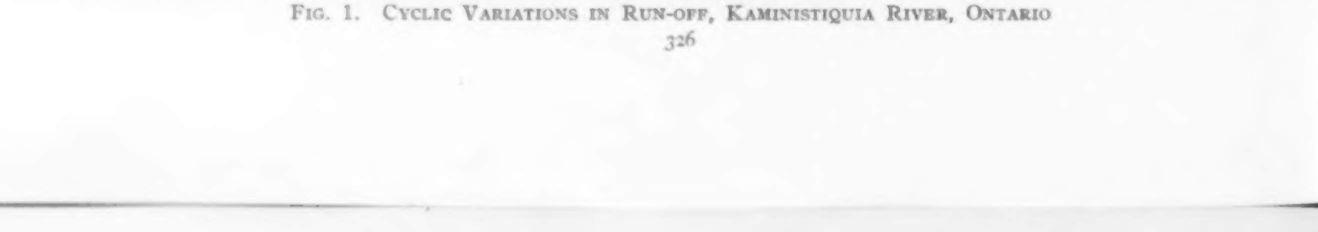




FIG. 1. CYCLIC VARIATIONS IN RUN-OFF, KAMINISTIQUIA RIVER, ONTARIO

but by reference to other rivers in the same locality with longer records of run-off, it is possible to show the Brückner Cycle, which is the guiding control of the Double Wolf Cycle, and also to mark in the still longer swing cycle, called the Secular Cycle, which in turn is the median path of the Brückner Cycle. Brückner published his work, *Klimaschwankungen Seit 1700*, over 40

Table I. Run-Off of Kaministiquia River, Ontario

Tabular Calculations for Double-Wolf and Clough Cycles

| Year (1) | Average Annual Run-off Sec-ft. (2) | $R1$ (3) | (4) | $\frac{\text{Col.(4)}}{4} = R2$ (5) | Col.(2)−Col.(5) $= S1$ (6) | $M1$ (7) | $S1-M1$ Clough (8) | $R2+M1$ Double Wolf (9) |
|---|---|---|---|---|---|---|---|---|
| 1908 | 1,378 | ... | ... | ... | ... | ... | ... | ... |
| 09 | 1,096 | 2,474 | ... | 1,102 | − 6 | − 45 | + 39 | 1,057 |
| 1910 | 839 | 1,935 | 4,409 | 986 | −147 | − 65 | − 82 | 921 |
| 11 | 1,172 | 2,011 | 3,946 | 1,134 | + 38 | − 15 | + 53 | 1,119 |
| 12 | 1,352 | 2,524 | 4,535 | 1,265 | + 87 | + 5 | + 82 | 1,270 |
| 13 | 1,185 | 2,537 | 5,061 | 1,271 | − 86 | − 38 | − 48 | 1,233 |
| 14 | 1,362 | 2,547 | 5,084 | 1,390 | − 28 | − 52 | + 24 | 1,338 |
| 1915 | 1,651 | 3,013 | 5,560 | 1,691 | − 40 | + 28 | − 68 | 1,719 |
| 16 | 2,101 | 3,752 | 6,765 | 1,724 | +378 | +175 | +202 | 1,899 |
| 17 | 1,042 | 3,143 | 6,895 | 1,381 | −339 | −137 | −202 | 1,244 |
| 18 | 1,340 | 2,382 | 5,525 | 1,205 | +135 | − 45 | +170 | 1,160 |
| 19 | 1,100 | 2,440 | 4,822 | 1,267 | −167 | + 3 | −170 | 1,270 |
| 1920 | 1,529 | 2,629 | 5,069 | 1,400 | +129 | + 50 | + 79 | 1,450 |
| 21 | 1,444 | 2,973 | 5,602 | 1,414 | + 30 | + 64 | − 34 | 1,478 |
| 22 | 1,241 | 2,685 | 5,658 | 1,198 | + 43 | − 25 | + 68 | 1,173 |
| 23 | 867 | 2,108 | 4,793 | 1,044 | −177 | − 75 | −102 | 969 |
| 24 | 1,201 | 2,068 | 4,176 | 1,157 | + 44 | − 50 | + 94 | 1,107 |
| 1925 | 1,360 | 2,561 | 4,629 | 1,479 | −119 | − 5 | −114 | 1,474 |
| 26 | 1,995 | 3,355 | 5,916 | 1,940 | + 55 | + 35 | + 20 | 1,975 |
| 27 | 2,410 | 4,405 | 7,760 | 2,093 | +317 | +140 | +177 | 2,233 |
| 28 | 1,576 | 3,986 | 8,391 | 1,678 | −102 | + 75 | −177 | 1,753 |
| 29 | 1,110 | 2,686 | 6,672 | ... | ... | ... | ... | ... |

years ago, and it has been referred to by Streiff in the *Monthly Weather Review* for July 1926.

The whole structure of flow of the river is now apparent. Back in the 1870's, the mean annual flow must have been much larger than it is at present, because the Secular Cycle was higher. The flow for 1930 is bound to be relatively low. About 1932 to 1933 there will be a considerable increase, and again about 1937 to 1939. The Brückner Cycle is now trending upward, as well as the Secular Cycle, whose next high point will probably be reached from 1945 to 1950. The flow conditions centering around 1950 will undoubtedly reach the high values that must have occurred back in the 1870's.

# A Device for Lining-in Between Two Fixed Points

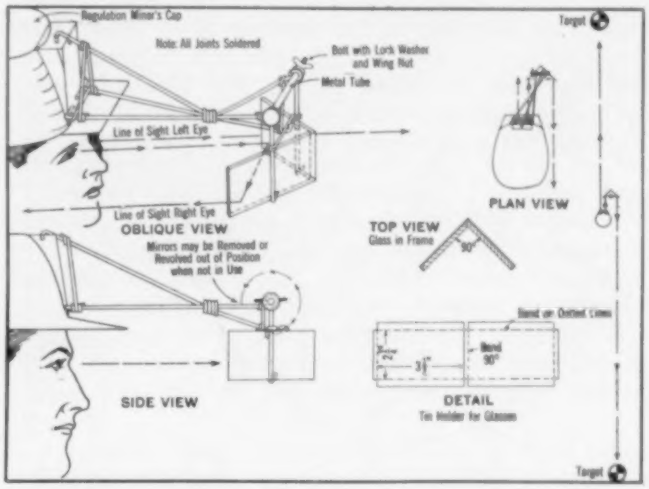
*By* L. P. Murphy

President Student Chapter, American Society of Civil Engineers, University of Illinois, Urbana

In sounding rivers and small lakes, it is a common practice to lay out range lines by setting a flag on each bank, taking soundings from a boat while running between the flags, and intersecting these soundings by a transit or sextant. The accuracy of the work depends a great deal upon the boatman's ability to keep his boat on line.

It is difficult for a boatman to do this without some means of lining himself. Where the banks are steep and vegetation is close to the water, it is expensive to cut a line back far enough to set two flags on line with the opposite bank flag. It is also expensive and unsatisfactory to keep a man on the bank to wave the boatman on line.

To overcome these difficulties, I constructed the device shown in the sketch, to be worn by the boatman, which gives him exact control of his location. This was found very useful in numerous other ways during the survey work. In fact, new uses were continually being found for it.




Mirror Device for Lining-in Between Two Points

The device is made up of two mirrors placed at right angles to each other, connected to a miner's cap by a wire frame. When in use, one of the mirrors falls directly in front of one eye of the boatman, directing the line of sight back past the side of his head. The line of sight of the other eye is ahead and parallel to the back line of sight. When the rear flag and the fore flag coincide, or one is directly above the other, the two flags and the instrument are in a straight line. It takes a little practice in order to accustom the eyes to work together in this way. Those who cannot use both eyes may use one and, by nodding the head slightly, look into and then under the mirrors, thereby obtaining the same results.

In constructing this device, care must be taken to see that the mirrors form an angle of exactly 90 deg. I found it difficult to do this by instruments, but by using a transit to lay out three points on a line, setting the mirrors at the middle point and adjusting them so that the two remaining points coincided, the job was very satisfactorily and easily accomplished.

# Our Readers Say—

## Mechanics of Chinese Windmills

Dear Sir: Civil Engineering has contained two interesting articles by E. W. Lane concerning the ingenuity of the ancient Chinese. Among the devices described and illustrated in October was the Chinese windmill. In 1921, while in the service of the China Famine Relief of the American Red Cross, I made a study of these windmills with a view to their possible application to pumping water from wells for irrigating

the Chihli Plains, and it would perhaps be worth while to discuss the theory of their operation.

The ones which I observed were near Tangku on the Gulf of Peichihli and were used to pump up sea water for the manufacture of salt. A central post some 20 ft. long was pivoted at the top and bottom and carried 8 radial arms at both top and bottom, each about 15 ft. long. Each pair of arms supported a vertical mast, which carried a sail of cloth between horizontal booms. These were attached to the mast at about their third points by loops and the longer ends were fastened to the following mast as shown in Fig. 1. The sails were arranged so that they could be lowered to avoid destruction when the wind velocity became too great.


FIG. 1. THE CHINESE WINDMILL

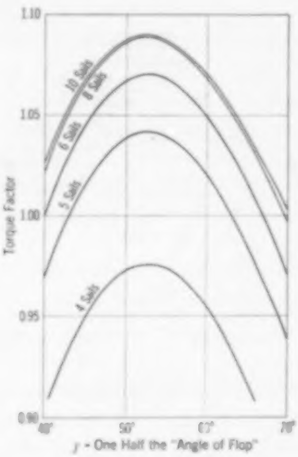



FIG. 2. TORQUE FACTOR

From position $A$ to position $E$ the wider part of the sail is inward and the face of the sail makes only a small angle with the radius. As the sail passes position $E$, the wind catches it on the opposite side and it "flops" to the other position, in which the wider part of the sail is outward. It continues in this position until it reaches a point between $F$ and $G$, when the sail is again edgewise to the wind and the ropes become slack. From here to the original position the sail is idle and remains parallel to the direction of the wind. The interesting point is that, by a principle similar to that by which a boat proceeds against the wind, the sail furnishes power through much more than half a revolution.

Assuming, as rough approximations, that the resultant wind pressure is perpendicular to the sail at its midpoint and is equal to $0.003\ v^2 \sin\phi$, where $v$ = the wind velocity and $\phi$ is the angle that the sail makes with the direction of the wind, we find by writing the expressions for moments about the axis and integrating, that the average torque per square foot of sail area is $\frac{0.003v^2r}{\pi}$ times a factor, the values of which are plotted in Fig. 2. This factor multiplied by $0.006v^2r$ times the total sail area will give the work per revolution. It is evident that 6 sails are noticeably more efficient than 4, but that there is very little advantage in increasing the number beyond 8; also that the maximum torque is obtained by making the half-flop angle about $52^1/_2$ deg.

For any given radius, increasing the number of sails requires a corresponding decrease in their width. Assuming that the maximum feasible width is 0.7 of the distance between masts, we have for the special case of a mill of 8 sails 15 ft. high, with $r$ also 15 ft., the following results: distance between masts = $0.765r$ = 11.48 ft.; width of sail = $0.7 \times 11.48$ = 8.04 ft.; total sail area = $8.04 \times 15 \times 8$ = 964 sq. ft.; factor from Fig. 2 = 1.088; work per revolution = $1.088 \times 0.006 \times 15 \times 964\ v^2 = 946\ v^2$.

As soon as the mill begins to turn, the relative velocity of wind and sail becomes less than the actual wind velocity. But for irrigation work, the important point is to get enough torque to raise water to the surface. A slight increase in wind velocity above this critical value will give a reasonable speed, and larger increases would lead to very great increases in speed and power.

Assuming that a 10 mile per hour wind will give a mast velocity of 6 miles per hour and an average velocity of sail to air of 6 miles per hour, the work per revolution will be $946 \times 36$ = 3,400 ft-lb. At 6 miles an hour, it will make 5.6 revolutions per minute and the gross horsepower will be 0.58. But doubling the wind velocity would more than double the speed and would make the torque 4 times as much, so that the power would be perhaps 5 or 6 hp. A mill of this sort will do no more work than three or four men until the wind velocity is greater than about 10 miles an hour, when the power increases very rapidly.

RALPH W. POWELL, Assoc. M. Am. Soc. C.E.
*Assistant Professor of Mechanics, Ohio State University*

*Columbus, Ohio*
*December 8, 1930*

## Progress in China

DEAR SIR: The contributions by Mr. Lane on the engineering of the ancient Chinese, which have appeared in recent issues, are timely in view of the large number of foreign engineers who visited China during the past year, particularly after the World Engineering Congress in Japan. They had just seen one oriental country which amazed and delighted them by displaying a development in engineering and industrial lines comparable to that of any Western nation. When they went to China they found another oriental country, apparently hundreds of years behind the times, and the contrast was so striking that bad impressions were naturally created and pessimism as to the future of this vast nation became the dominant note in many expressions of opinion.

Why is it that in the last century China has remained virtually at a standstill? Does she lack inherent technical and mechanical ability to produce an industrialized, comfortable civilization like ours? Any one who has associated with Chinese technical men knows that they are just as able as any in the world. Chinese student engineers display an aptitude comparable to that of our own American students. In the structural engineering courses at the Ministry of Railways' university in Shanghai, I gave 60 students identically the same courses that I had given two preceding classes at the University of Illinois. Despite language handicaps, the class average of the two groups was practically the same. Of course, there are less extracurricular activities at present to divert attention from studies in Chinese universities, but they are rapidly developing activities of this type.

Once they have been correctly trained, skilled workmen in China are the equal of any. There is a dearth of skilled workmen and trained technical men throughout the country, but this is not because there is a lack of essential ability.

While a great reverence for their dead is a part of the religion of the Chinese, they do not consider the ways of their ancestors as established precedents from which no deviation is possible. When they find out that there are better ways of doing things they change their practice. Take the case of Hangchow, the capitol of progressive Chekiang Province. Some years ago, rebel cannon mounted on a nearby hill blew a large part of the old Manchu city along the shores of West Lake to atoms. Funds were available and the section was rebuilt with wide, paved streets, boulevards, park strips, sewers, sidewalks, electric lights, and telephone service. At present, a municipal water supply is under construction. Other cities are following suit, but the changes are hardly preceptible in most places.

The great lack of progress is due to causes which are evident to any foreigner who has had the opportunity to associate with the Chinese people in their native land. Anarchy and corruption stalk through the land, breeding poverty, disease, and ignorance. Many Chinese are well aware of the presence of these five devils which oppress their country, but a widespread, mutual suspicion of one another seems to preclude the effective cooperation so necessary for the elimination of the evils.

The present government at Nanking, composed chiefly of American-trained university men, has shouldered a heavy burden. Although not perfect by any means, it is doing a better job than its predecessors for many years have done. There are in its organization men of high ideals, men who recognize their responsibility and who have the national welfare at heart. The least that we can do is to try to understand their problems, lend a helping hand whenever we can, and refrain from destructive criticism.

Harold E. Wessman, Assoc. M. Am. Soc. C.E.
*Waddell and Hardesty, Consulting Engineers*

*New York, N.Y.*
*December 10, 1930*

## More Concerning Manhattan's Transportation Problem

To the Editor: The transfer of passengers from one side of Manhattan to the other by running through trains across town, as proposed by Mr. Stuart in the October issue, would be difficult and expensive, and probably undesirable. The only practical way of providing for a service of that kind is largely by cross-town lines with adequate transfer facilities.

A serious doubt as to the practicability, from a financial viewpoint, of extending transportation lines from the Grand Central and Times Square southward is raised by the fact that but a small proportion of commuters from Westchester and Long Island have occasion to go to lower Manhattan. New subway lines under construction and contemplated will greatly relieve the pressure on express trains at Times Square and the Grand Central Terminal. The question of extending the through tracks of the New York Central, the New Haven and the Pennsylvania Railroad arose several years ago but neither the city nor the railroads were favorable to it because, if any such facility were provided, the expectation of the commuter would be that the charge for the additional ride would not exceed five cents, or might be even less in view of what he had already paid.

The delays and difficulties in getting on and off the existing East River bridges would probably justify the city in paying more per lane of traffic for tunnels, and thereby distributing its travel to a number of different points, rather than by the construction of such a bridge as that proposed across the Hudson at 57th Street, with its many lanes of traffic concentrated at one point in Manhattan, even though the railroads crossing the bridge might be put into tunnels to carry them across the island.

The Tri-Borough Bridge and a new rapid transit line now under construction, and other rapid transit lines under consideration will aid in enabling people from various parts of the Metropolitan District to reach other parts without having to travel through Manhattan, thus overcoming one of the difficulties mentioned by Mr. Stuart.

The proposal of an operating company, composed of all of the railroads, to operate the facilities described by Mr. Stuart, seems impracticable because of the unfavorable attitude of the railroads to such a scheme. The attitude of the Long Island Railroad is that it does not wish to bother with any but long-haul passengers. It prefers not to handle intra-city passenger traffic. There seems to be but little chance of the Long Island Railroad and the Pennsylvania Railroad joining in with a proposition of financing subways and tubes to provide for the distribution of traffic in Manhattan.

The situation in New Jersey differs from that in Westchester and Long Island and the provision of some sort of transportation line which would tap, by means of transfers, the numerous and scattered lines which come in at various points in New Jersey and then carry them by means of a subway into Manhattan, where perhaps they might again transfer to existing lines, would relieve the situation there.

As the subways are now operated, we get a partial two-way load, but if commuter trains were brought in there would be absolutely empty cars on the return trip; and while there are not absolutely full loads in both directions on the subways, they are almost so when compared with the conditions which would exist on these commuter trains.

John R. Slattery, M. Am. Soc. C.E.
*Deputy Chief Engineer, Board of Transportation*

*New York, N.Y.*
*November 25, 1930*

## The Suburban Transit Engineering Board

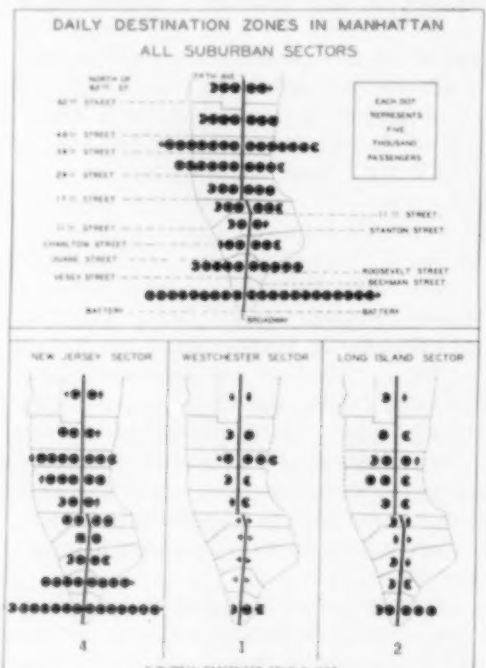
To the Editor: Many of the principles set forth by Mr. Stuart in "Solving Manhattan's Transportation Problem," which appeared in Civil Engineering for October, are not far different from those which the Sub-

urban Transit Engineering Board has been studying, and which were presented in its progress report last March.

The Suburban Board has been working on suburban transit plans for the past three years. Created in 1927 by invitation, it is a central agency bringing together all the groups working on this problem of suburban transit.

At the present time all suburban passengers are brought into 13 terminals which, with two exceptions, are close to business Manhattan below 59th Street. Of these terminals, 5 are on the New Jersey side of the Hudson River, 4 in Manhattan, 2 in the Bronx, and 2 on Long Island.

One of the first problems confronting this board was to determine where the suburban passengers come from and where they want to go. To accomplish this, a suburban passenger traffic census was taken in 1927 by distributing cards to all inbound passengers on all railroads and asking each passenger to check certain information concerning his daily riding habit and ultimate destination in Manhattan. A similar census had been taken in 1924 by the North Jersey Transit Commission.




GRAPH SHOWING DAILY PASSENGER DESTINATIONS

From these two censuses it was found that more than 90 per cent of all the passengers on suburban railroads on a typical day went to Manhattan, and that from 40 to 50 per cent of the total number of passengers traveling toward Manhattan in the 24-hr. period traveled during one hour in the morning.

They also indicated that the suburbanites, to a large extent, live in the particular sector of the metropolitan district from which it is most convenient to reach their places of business in Manhattan. Thus, by far the larger percentage of passengers from Westchester have business destinations in the Grand Central district. The Pennsylvania Station district and the financial district below Vesey Street are the objectives of a majority of passengers from the Long Island sector. In like manner, the districts adjacent to the terminals of the Hudson and Manhattan at 33d Street and the Hudson Terminal are the destinations of the bulk of the passengers from New Jersey. These destination zones are best shown in the accompanying chart.

The proportion of suburban passengers arriving from the different sectors is in the approximate ratio of 1 from Westchester, 2 from Long Island, and 4 from New Jersey, but conditions are such that Long Island seems to be gaining passenger traffic faster than the other sectors. Recent traffic figures show that there were nearly 23,000 more passengers riding on suburban trains in 1928 than on a corresponding day in 1926. One-half of these were from the Long Island sector, about 9,000 from Westchester, and only about 2,000 from New Jersey. Traffic in the New York Metropolitan District has grown to such an extent that in 1928 the total passengers from the 40-mile zone about New York represented 48.4 per cent of the passengers on Class I railroads in the whole United States.

With these facts before the Suburban Board, their studies indicate that additional mass transportation facilities should be provided for suburban transit, collecting the passengers at convenient points of intersection with the trunk-line railroads in the suburban sectors and distributing them through business Manhattan in a suburban trunk subway, separate and apart from the existing city subways. In this respect their studies are very similar to the plan suggested by Mr. Stuart.

The Suburban Board's progress report of last March indicated studies of suburban routes which would provide loop operation from Jamaica, on the Long Island Railroad, to and through a suburban trunk subway extending from the Battery to 57th Street. Extensions were indicated from this suburban trunk under the Hudson to New Durham, N.J., to connect with the Northern Railroad of New Jersey with the New York, Susquehanna and Western, and with the West Shore Railroad. Another extension was indicated under the Hudson River to Communipaw to connect with the Central Railroad of New Jersey, and another to the uptown branch of the Hudson and Manhattan, connecting the 33d Street terminal with the suburban extension to New Jersey. These routes have not been adopted by the Suburban Board and have been indicated for study purposes only.

Questions as to who would operate such a system or how it would be financed remain to be answered.

GLENN S. REEVES, M. Am. Soc. C.E.
*Secretary, Suburban Transit Engineering Board*

*New York, N. Y.*
*December 1, 1930*

# Filter Clogged with Inorganic Iron Salts Not Self-Cleansing

DEAR SIR: Although trickling filters for the treatment of municipal sewage have been in operation in this country for about 22 years, the exact basis for the selection of filtering material is still a matter of discussion and study. The desirable characteristics pointed out by Mr. Jones in the November issue of CIVIL ENGINEERING are well known, that is durability and uniform size.

On the other hand, the most advantageous size has not been fixed, except within fairly wide limits, nor has the proper surface texture been determined. It is important to select filtering material with the view of avoiding undue accumulations of solids within the voids, but it is sometimes astonishing to note the extent to which filters may become clogged and then unload.

An instance of serious clogging followed by complete unloading occurred at the sewage treatment plant at Reading, Pa., in the fall of 1925. Due to the fact that the preliminary sedimentation tank had not been cleaned for many months, large quantities of sludge solids passed into the filters. These solids clogged the filters to the extent of forming a typical sludge mat upon the filter surfaces. The plant was shut down for several weeks in order to permit cleaning of the sedimentation tank. Following resumption of operation, the filters unloaded, and three years later the filter material was apparently as clean as when originally placed. It is also of interest to note that the filters at Reading were constructed of poorly graded material, and, in the case of one filter at least, of easily disintegrated rock.

Another instance of trickling filter clogging occurred at Fostoria, Ohio, in 1929. Unlike the Reading filters, the filtering material at Fostoria was in accordance with the best modern practice. In spite of the care in the selection of the filter media, the filter became clogged in less than a year of operation to such an extent as to require removal and cleaning of the filter stone. The major difference between Reading and Fostoria conditions lay in the fact that at Reading the clogging solids were largely organic and those at Fostoria largely inorganic iron salts. At the latter plant, resting and chlorination both failed to be of value in effecting the removal of the deposits within the filter voids.

The two instances cited indicate that the character of the filtering material may be of relatively minor importance as compared with the character of the clogging solids. The effectiveness of preliminary treatment as regards removal of suspended solids is undoubtedly another important factor in this connection.

E. Sherman Chase, M. Am. Soc. C.E.
*Metcalf and Eddy, Engineers*

*Boston, Mass.*
*November 22, 1930*

## Iron Precipitation in Trickling Filters

To the Editor: The relation of various factors of filter construction and operation to media clogging has been well presented by Mr. Jones in the November issue of Civil Engineering. The media should be of durable material, clean, and of proper and uniform size. Even distribution, free drainage, and effective aeration are essential to efficient operation.

Surface clogging of filters due to growths can be remedied, but that due to disintegration of the material will ultimately destroy the filter. The same is true of media within the filter in case of disintegration. These conditions may be due to the character of the media selected or to the action of the influent or elements upon the media. The remaining essentials of design and construction are matters of engineering consideration.

The character of the sewage and the efficiency of its preliminary treatment are operating factors involved in media clogging. The precipitation, of iron particularly, within a filter is an important factor to be considered in connection with trickling filters.

The Worcester trickling filter media consist of bastard granite in one area and trap rock in three areas. Five years of operation have disclosed no radical difference in the results obtained with the two media. No difficulties have been experienced with surface clogging which did not disappear in the spring, formerly with harrow treatment and, recently, without treatment of any kind. Unloading of the filters has occurred regularly and effectively so that pooling of the filter and consequent poor results of operation due to media clogging have not been experienced. The average rate of operation of the filters, 10 ft. deep, with material ranging from $1^1/_2$ to 3 in. in size, has been about 1.5 million gallons per acre per day.

Interest of the engineering profession in the operation of the Worcester filters is greatly concerned with the iron content of the filter influent, which average varies from 40 to 60 parts per million as Fe. The content of doses of acid iron in the influent greatly exceeds these figures for periods of short duration. No attempts have been made to determine by sustained periods of high rate of operation of a part of the filter area whether media clogging would result from precipitation of iron or overloading with organic suspended solids.

Roy S. Lanphear
*Supervising Chemist, Sewer Department, City of Worcester*

*Worcester, Mass.*
*November 26, 1930*

## Operation of Sewage Works

Dear Sir: I wish to make the following comments on the abstract of the Sanitary Engineering Division committee report, published in the November issue of Civil Engineering. It would seem that proportioning the cost of operation of sewage plants receiving industrial waste should be based upon the strength (bio-chemical oxygen demand) and the volume of waste when the trade waste is organic (putrescible) in nature; when organic but inert (such as rubber), upon the suspended solids and volume; and, when inorganic in nature (such as iron and clay), upon suspended solids and volume. For dye wastes and similar industrial wastes a still different method of cost calculation would be necessary. Taxing upon a volume basis alone would be unnecessarily hard on some industries and easy on others.

It does not seem logical to classify superintendents of sewage works according to the population connected. It would seem more proper to classify them in accordance with the type of treatment plant, because a number of smaller towns have and will have complete treatment works. Classification on the basis of treatment works could possibly be; (A) complete treatment, such as activated sludge, settling, digestion and trickling filters; (B) incomplete treatment, such as settling, digestion, and chlorination; and (C) partial treatment, such as screening and chlorination. Group supervision of smaller

plants by a competent Class A man, with Class B and Class C men present at the works, would be the natural outgrowth.

Short schools for sewage-works operators should be given primarily for operators of small plants and for non-technically trained men of large disposal works. Practice has shown that the courses must be given in sections and should be of two weeks duration. With at least two successive courses, in a period of two years, the operator seems to derive most benefit. Cooperation between the educational institution, board of health, and sewage works association is of great advantage.

It is doubtful if the tests given by the committee to be required at treatment works should be made in the order given. Tests for albuminoid nitrogen and oxygen consumed, if made at all, should be placed at the end of the test, with such tests as suspended solids and biochemical oxygen demand first.

Keeping of records of cost of operation and maintenance, together with records on the performance of the plant, are important, but the benefit derived from them would be greater if the information obtained from all plants were recorded in a uniform manner. Closer cooperation between the Sanitary Engineering Division and the various State Sanitary Engineers might go a long way.

W. RUDOLFS
*Chief, Department of Sewage Research,*
*New Jersey Agricultural Experiment Station*

*New Brunswick, N.J.*
*November 26, 1930*

## A Junior Member's Reaction

DEAR SIR: In the November issue of CIVIL ENGINEERING, I read with great interest the abstract of the committee report, "Practical Operation of Sewage Works." Having graduated from the University of Illinois in sanitary engineering, and having kept in touch with the men I knew there, I feel as though I am justly able to give you the thoughts of men of my training and experience when they read an article such as the one mentioned above.

First of all, I believe that not one graduate in sanitary engineering from the University of Illinois in the past four years has obtained a position as plant operator. Neither have any of them been able to obtain such work as would give them the experience required by the recommendations in the report. Instead, we must take the closest thing to it that we can get, which usually is just design and construction work.

Fully 50 per cent of the graduates in this course would jump at an opportunity to get work and experience in this line. And the article says trained men are lacking. There are plenty of them. But they cannot get a position without experience and to get experience they cannot get a position.

For 18 months several of my fellow graduates have attempted to secure positions in this line, just as I have, and always with the same result. We have had the best training we can possibly get; some of us have had as much as three years experience in municipal design and construction work; but it is of no use. Two plants I know of have operators who had poor high school records, no college training of any kind, and no experience at all.

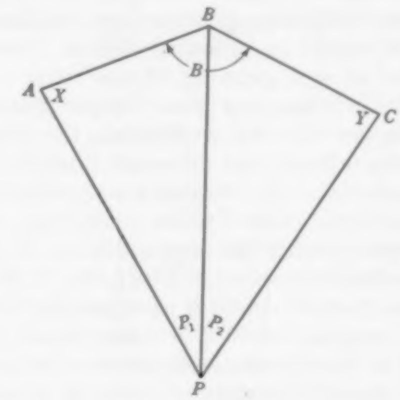
In our estimation, the article is very misleading—if not, why are we not all so placed that we can get experience in this line? We are all convinced that if men really are needed, it is a case of whom you know and not what you know. I wish several of us could talk to members of the Sanitary Engineering committee. When we apply for positions, even to some of the men who helped prepare this committee report, we often do not even have our letters acknowledged.

MARVIN B. FIERKE, Jun. Am. Soc. C.E.

*Chicago, Ill.*
*November 13, 1930*

## The Three-Point Problem

DEAR SIR: In my recent article entitled "The Three-Point Problem Simplified," which appeared on page 132 of the November issue of CIVIL ENGINEERING, it was not clearly indicated as to what really constitutes the three-point problem. The angles $X$ and $Y$ in that problem are not actually two angles of an oblique triangle, nor is it necessary to compute the sides $x$ and $y$.




What I desired to convey was that, given the sum and sines of the two angles, $X$ and $Y$, as they appear in the three-point problem, it is possible to utilize the fundamental equations of an oblique triangle for their solution.

This may be demonstrated by reference to the diagram given by D. L. Reaburn in his discussion of E. A. Bayley's paper, on page 1347 of the August PROCEEDINGS of the Society, and which is reproduced here for convenience.

It is quite evident in this figure that the angles $X$ and $Y$ are not given as angles of a triangle, but are angles of a quadrilateral, and the distances $x$ and $y$ have no real existence. In this quadrilateral, the sides $AB$ and $BC$, and the angles $B$, $P_1$ and $P_2$ are given, and the problem is to determine values for angles $X$ and $Y$.

Now $X + Y = 360° - (B + P_1 + P_2)$ or, putting it in another form, $X + Y = 180° - (B + P_1 + P_2 - 180°)$.

Calling the expression within the brackets $Z$, we have $X + Y = 180° - Z$, which is readily recognized as the relation between the three angles of an oblique triangle and, in the solution, the values $x$ and $y$ are the sides opposite the angles $X$ and $Y$ of this proposed triangle.

It therefore follows that any formula for an oblique triangle may be used in the determination of the angles, and Solution 1 of my article in the October issue logically follows.

James B. Goodwin, M. Am. Soc. C.E.
*Engineer, Hydro-Electric Power Commission*

*Ontario, Canada*
*November 14, 1930*

## Discussion Needed on Details of Hoover Dam

To the Editor: The Boulder Canyon project, so well described in the leading article of the October number of Civil Engineering by Dr. Elwood Mead, Commissioner of Reclamation, evidences the courage and confidence with which American engineers are prepared to attack engineering problems of the greatest magnitude. He brings us a picture of structures of the most daring type, a dam twice the height—or very nearly so—of any heretofore constructed and now in successful operation, and a canal through an area of ten miles covered with drifting sand dunes which rise to heights of more than 100 ft.

The engineering profession will await with great interest the disclosure of the studies which have been and are about to be made for the solution of the many problems connected with so vast an undertaking. Dr. Mead merely gives a hint of what is involved when he refers to the physical properties and volumetric changes of so great a mass of concrete as will be placed in the Hoover Dam. The volumetric changes may continue to manifest themselves for some time after the concrete is placed unless suitable precautionary measures are taken to prevent undue heating of the interior of the dam while the concrete takes its permanent set.

Neither does he go into detail about foundation and abutment drainage to prevent uplift, nor about means that are to be taken to prevent undue saturation of the concrete under full reservoir conditions. It is hoped that this first paper will be speedily followed by others. This should stimulate discussion, beneficial alike to the engineering staff on the great work and to the entire engineering profession.

C. E. Grunsky, M. Am. Soc. C.E.
*Manager, C. E. Grunsky Company, Engineers*

*San Francisco, Calif.*
*November 13, 1930*

## What the Society Can Do for the Junior Member

To the Editor: At the spring meeting of the Board of Direction of the Society last April, discussion was opened concerning the Junior members and their activities with the Society. It was the sense of the meeting that the Directors endeavor to draw the interest of the younger men to the organization by a specially prepared program in which they would take active part.

At a meeting of the Georgia Section for that purpose I felt unusually honored in being asked to make these statements for the Junior members of the Section.

It is the usual condition that the younger man should be a good listener until he has something to say that will interest others. However, the question as to what the Society can do for the Junior member can only be answered by one who is a Junior himself.

Frankly, I do not see how any one could be interested in what the Society "means" to the younger men. This organization has a well-defined purpose and that purpose is what the Society should mean to the new member. He has joined a professional group and realized that by so doing he will obtain certain well-known benefits. However, on the other hand, the question as to what the Society can do to interest the Junior is more constructive, for to interest him they must first know his needs. These needs will be the substance of this short résumé.

When a young man finishes school he has a mathematical idea of engineering. For four years he has lived in a field of figures and for a time after school he believes that they will still tell the whole story. Then indeterminate problems come up. What is to happen to the young designer? He needs a bit of expert advice. He is a Junior member in a society of experts. What better thing can the older members do than lend a little of their sound judgment to the younger men?

A committee might be appointed having a card index of the Associates and Members in the Section with their addresses, type of work, and specialties and which would form an advisory board for such Juniors as may seek certain professional advice. Of course, by advice I do not mean time-taking discussion, merely an opinion that will show the young member a way out of a difficulty on a certain job that an older head would see in a moment.

The American Society of Civil Engineers is an organization of experts in that branch of engineering. In order to maintain an organization of experts, this quality must be developed in the younger men. The best way to develop it is to recommend, or at least encourage, some graduate work under the supervision of technical experts. Our own technical school here in Atlanta offers graduate work at night for an unusually reasonable fee. Why not show our approval of such work by sending to the younger members of the Sections a descriptive letter just before the new semester opens with details of the benefits derived from such study?

Coupled with the graduate studies comes research. Georgia has very few good research laboratories in Civil Engineering because our legislators do not comprehend the magnitude of such development. Why should other States lead in this field? Georgia is progressing and why shouldn't a little lobbying be resorted to to influence the passing of a bill providing funds for this important field of development?

So much for the technical side of the Junior member in the Society. Suppose one dance a year sponsored by the Juniors were added to the social program of the Section. This could be a yearly affair just as the dinner dance is now. Then we could have a winter formal and a summer informal, making the social sessions only a half year apart instead of a year. I am sure that the Juniors would enjoy this added social activity and enter into it with very great interest.

The medical profession and the legal profession start in school by impressing upon the novice the dignity of the profession. The technical school seems to lack this quality. They seem to have forgotten to tell us often enough while we are in school of the great responsibility which rests on the civil engineer. It is up to the Society, it seems, to impress this feeling on the Junior and make him feel that life actually depends on his judgment and accuracy in the design of public works.

H. J. STEMM, Jun. Am. Soc. C.E.
*Designer, Allied Engineers, Inc.*

*Atlanta, Ga.*
*December 15, 1930*

## Credit Where Credit Is Due

DEAR SIR: In writing the paper entitled "Blasting a Precast Dam into Place," as published in the December 1930 issue of CIVIL ENGINEERING, I inadvertently omitted the names of James P. Growdon, M.A.I.E.E., Assistant Chief Hydraulic Engineer of the Aluminum Company of America; I. G. Calderwood, M. Am. Soc. C.E., General Superintendent; and Ross White, M. Am. Soc. C.E., Assistant General Superintendent, Alcoa Power Company, Ltd. These three men were so pre-eminently identified with the design and construction of the Chute à Caron development that, in recognition of their services, it is only fair that attention should be called to the above-mentioned omission.

C. P. DUNN, M. Am. Soc. C.E.
*Chief Engineer,*
*Alcoa Power Company, Ltd.*

*Arvida, Quebec, Canada*
*December 12, 1930*

## Some Working Data for Welding

DEAR SIR: I have been studying the article by Frank P. McKibben, which appeared in CIVIL ENGINEERING for October, and I have found it very complete and comprehensive. It is a very good piece of work and very appropriate at the present time.

With reference to electrode consumption when making fillet welds, I note the assumption is made that each electrode is used up to a 2-in. stub and, as a comparison to this, the actual amount used per inch of weld on a particular job, mostly $^3/_8$-in. fillets, was 0.0429 lb. This means that about 24 in. of weld is completed with a pound of electrode.

Actually, the structural welder cannot be so economical as to limit his stub ends to a maximum of 2 in. because he is welding in various positions and under varying conditions which often require him to discard a stub longer than 2 in. and start a new electrode for the weld. For flat fillet welds in a convenient location, such as on the bench or floor, I have found that the stub end usually is under 2 in. in length and that the amount of electrode consumed for a $^3/_8$-in. fillet is about $^1/_2$ lb. per ft. of weld, when using a $^3/_{16}$-in. electrode at 200 amperes.

I note also that, on an actual job, the speed of welding column splices and beam connections amounted to 50 in. of $^3/_8$-in. fillet per hr. On flat work, where the welding may be done continuously and the welder can work conveniently, the weld may be made at a speed of about 3 in. per min., or 180 per hr. on a continuous basis. Obviously, on structural work, the amount of time required to change position and get ready to weld is the largest item. It therefore behooves the designer and erector to give these items serious consideration so as to cut down these costs, wherever possible, within reasonable limits.

It seems to me that one of the greatest obstacles to the use of welding in building construction is the lack of available machinery for competent inspection for both shop and field erection, but this situation will undoubtedly be changed as the demand for this form of construction increases.

W. L. WARNER
*Welding Department,*
*General Electric Company*

*Schenectady, N. Y.*
*November 19, 1930*

## Flood Control and Aggregate Cooling

DEAR SIR: Dr. Mead's comprehensive description in the October issue of CIVIL ENGINEERING of the Colorado River problem as it affects the southwest was most timely. As Dr. Mead stated, the maximum flood occurring but once in 500 years will be reduced to 75,000 sec-ft. and the largest flood since 1900 to 48,000 sec-ft. The medium flow section of the river below the canyons is about 600 feet wide. Clear water from the reservoir will pick up a load and gradually lower the river bed. If the river is straightened somewhat and then controlled, the resulting channel will safely carry 75,000 sec-ft. before encroaching seriously on the levees.

Bill Williams River enters the Colorado between Topoc and Parker and at flood times may add materially to the flow of the latter.

Fortunately, the proposed diversion dam above Parker, to form part of the Metropolitan District aqueduct system, is located a short distance below the mouth of Bill Williams River and will greatly reduce the effect of the flashy floods from that stream.

The Gila, however, enters Colorado River at Yuma and at times carries very large floods. In fact, the largest floods passing Yuma in the past 40 years occurred in the winter when the Colorado furnished about twenty-five per cent. The last large flood from the Gila, in January 1916, added to the flow in the Colorado, reached a maximum of 240,000 second feet. Since that time storage on the Salt River has been increased by gates at Roosevelt, and by Horse Mesa, Mormon Flat and Stewart Mountain Dams. A dam on the Agua Fria, a tributary of the Gila, has created a 150,000 acre-foot storage reservoir, and Coolidge Dam across the Gila has added 1,300,000 acre-feet to the storage available to control the floods in the Gila and its tributaries.

The large floods in the Colorado occur in the early summer so they do not synchronize with those from the Gila. With the storage now available on the Gila, time enough would elapse to reduce the discharge at Hoover Dam to zero before the various reservoirs on the Gila overflowed. It may be necessary to provide a flood control reservoir on the Gila in order to reduce the

floods to a volume which can safely be carried by the river channel below Yuma where continually changing conditions make its control very difficult.

The design of Hoover Dam by the Bureau of Reclamation has resulted in a section which meets in a most efficient and satisfactory manner the rather severe conditions laid down by the Colorado River Board. Due to the great length up- and downstream, over 600 feet, and the enormous amount of heat generated by the setting of cement, about 140 B.T.U. per pound of cement, or over 50,000 B.T.U. per yard of concrete, much time and study has been given to the problem of holding the final temperature of the mass as low as possible. If there were no heat losses from the concrete the temperature rise would be between 65° and 70° F.

It is therefore necessary, in order to prevent cracks parallel to the axis of the dam, to dissipate this heat as rapidly as possible and to reduce the temperature of the water and aggregates before mixing, so the final temperature after chemical action has practically ceased will be as nearly as possible about 71° F., the average temperature at the damsite.

If the dam is constructed of precast concrete or rock laid in mortar and concrete, the amount of cement required and the consequent heat would be reduced, but precooling would still be necessary during a large part of the year. Summer temperatures of 100° are usual.

Louis C. Hill, M. Am. Soc. C.E.
*Quinton, Code and Hill-Leeds and Barnard Consulting Engineers*

*Los Angeles, Cal.*
*December 11, 1930*

## Index Technical Books as Well as Periodical Literature

Dear Sir: Dr. Flinn's stimulating paper, which appeared in the October issue of Civil Engineering, properly calls attention to the important role that libraries play in research work. This should be further emphasized because the usefulness of such libraries as that of the Engineering Societies in New York is too frequently overlooked or underestimated.

The compilation of a complete bibliography on any subject should not be the end and aim of any investigation, but no investigator is qualified for his task until he knows what others have accomplished. Failure to look up existing literature and learn what has already been done has sometimes led to expensive experimentation that merely confirmed facts already on record.

Unfortunately, there are comparatively few libraries that are sufficiently well provided with the literature of engineering to permit a thorough investigation to be made of any subject, and all investigators are not so conveniently located as to permit them to avail themselves personally of the facilities of the few complete engineering libraries. Library research, too, requires skill and intelligence of the same order as that needed in the laboratory, and time and money can often be saved by employing skilled searchers such as are available for this work at the Engineering Societies Library.

Dr. Flinn's suggestion that the results of research should be deposited in libraries is also worthy of careful notice. Much valuable work is lost because it has never been recorded in any permanent storehouse. Even if not printed, engineering libraries gladly receive and preserve any original work in manuscript. Records of failure are often as valuable as those of success; they prevent others from following the same path.

Cooperative effort should be directed toward the preparation of guides to the information that already exists in our libraries. Monographs, systematized abstracts, and indexes are all effective time savers in research work, and they are much too few. No greater service could be rendered the engineering profession than to make funds available to the Engineering Societies Library with which to do for the great mass of material in our library what is being done for current literature by the Engineering Index Service.

Walter E. Spear, M. Am. Soc. C.E.
*Department Engineer, Board of Water Supply*

*New York, N. Y.*
*November 21, 1930*

## Precedent Replaced by Scientific Analysis

To the Editor: I have read with much interest Mr. C. P. Dunn's paper in the December issue entitled "Blasting a Precast Dam into Place."

The credit due to Mr. Rickey and Mr. Dunn is primarily for demonstrating to the average precedent-limited, conservative engineer that mathematical laws apply just as well to an 11,000 ton block of concrete as to a smaller falling body or a pendulum.

The fact is that except for some small uncertainty as to the velocity of displacement of the water under the falling weight, and some danger of cracks by lack of perfect fit to the bottom, this problem was capable of just as accurate mathematical solution as any of the ordinary every-day problems of engineering design.

The oft-reputed divergence between theory and practice is not the failure of theory, but the fact that the theory is incomplete, or incorrectly applied. It is merely the fact that all of the conditions have not been introduced into the analysis.

The art and science of engineering advances just in proportion to, and as fast as new problems arise and engineers exist to solve them, having the power of analysis to correctly state and apply all of the attendant and governing conditions and principles and to apply necessary research if some principles are unknown, and the courage to believe their own conclusions.

We should all be proud of those rare men in the profession who occasionally wake us up to the fact that engineering has a scientific foundation, which can only be advanced by the application of scientific principles, and not by following precedent, conventions, rule-of-thumb, or handbooks.

L. F. Harza, M. Am. Soc. C.E.
*Harza Engineering Co. Consulting Engineers*

*Chicago, Ill.*
*December 18, 1930*

# SOCIETY AFFAIRS

*Official and Semi-Official*

## Prize Winners 1930

Charles Terzaghi

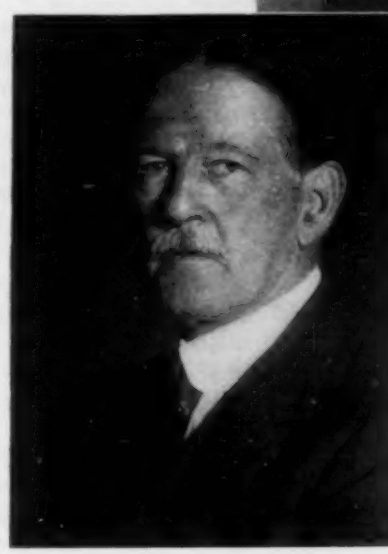
For the Norman Medal, Paper No. 1704, "The Science of Foundations—Its Present and Future."

H. de B. Parsons

For the J. James R. Croes Medal, Paper No. 1713, "Hydrostatic Uplift in Pervious Soils."

R. McC. Beanfield

For the Thomas Fitch Rowland Prize, Paper No. 1700, "Unusual Engineering Features of an Immense Theatre Building."



George Gibbs

For the Arthur M. Wellington Prize, Paper No. 1708, "The Virginian Railway Electrification."

C. B. Cornell C. B. Hoover John H. Gregory

For the James Laurie Prize, Paper No. 1715, "The O'Shaughnessy Dam and Reservoir."

## *Society Awards 1930 Prizes*

In June each year the Board of Direction is empowered to appoint three Corporate Members of the Society not on the Board, to recommend the award of prizes. This Prize Award Committee examines all papers that have been published in the previous year's TRANSACTIONS for compliance with the conditions of the Code of Rules. Awards are made by the Board of Direction based on the recommendations of the committee, and at the Annual Meeting the prizes are announced and awarded.

The gold Norman Medal, the dies for which are entrusted to the Philadelphia Mint, has a value of $60 and was endowed by the late George H. Norman, M. Am. Soc. C.E., in 1872. It is the oldest of the Society prizes. The Norman Medal is awarded for the most meritorious contribution to engineering science.

The first recipient of the Norman Medal was J. James R. Croes and in his honor the Society awards a gold medal of $40 value, as a prize second to the Norman Medal.

A prize for the best paper describing accomplished works of construction, with costs, was endowed by the late Thomas Fitch Rowland, Honorary Member of the Society, in the early eighties. Competition for this prize, consisting of $60 cash and an engraved certificate, is not limited to members of the Society.

As a second prize for papers describing accomplished works of construction, the Society awards the James Laurie Prize. Named in honor of the Society's first president, this prize consists of $40 in cash and an engraved certificate.

The Arthur M. Wellington Prize for papers on transportation by land, water, or air was established and endowed by *The Engineering News-Record* in 1921. It consists of $75 in cash and an engraved certificate.

Francis Collingwood established and endowed a prize in 1894 consisting of $50 in cash and an engraved certificate. Competition for this prize is limited to Juniors who describe engineering works or investigations with which the competitor was connected.

Photographs of the recipients of these prizes for 1930 are reproduced on a previous page together with the titles of the papers for which the awards were made. The Collingwood Prize for Juniors is not to be awarded this year.

## *Responsibility for a Splendid Meeting*

Presentation of the many technical features of the meeting of the Society held at St. Louis, October 1 to 4, 1930, is the exclusive subject of the technical part of this issue. It may seem to be a pity that abbreviation of the splendid papers is necessary. However, a mere glance at the size of the issue will show that limitations, although undesirable, have to be put in effect. Inevitably the reader must feel a twinge of regret that he could not have listened in person to these excellent papers and to have seen more of the illustrations, which are naturally subject to similar condensation in publication.

Behind such a fine meeting there must exist the necessary machinery, provided originally by Local Section officers and Society committees but, at closer range, by a large delegation of local members who are on the firing line and take the brunt of the heavy work. In the case of the St. Louis Meeting, general supervision was in the hands of an executive committee with the following members: W. W. Horner, Chairman, R. A. Willis, R. J. Lockwood, C. M. Talbert, W. J. Burton, B. L. Brown, F. W. Green, A. P. Greensfelder, C. W. S. Sammelman, W. R. Crecelius, E. O. Sweetser, J. C. Travilla, H. E. Frech, and William E. Rolfe.

Individual items, which were so capably handled, were in the hands of almost a hundred local members and their wives, arranged in many groups which did splendid work. These committees with their respective chairmen were as follows: Finance Committee, R. J. Lockwood; Program Committee, F. W. Green; Entertainment Committee, H. E. Frech; Reception Committee, E. O. Sweetser; Publicity Committee, W. J. Burton; Hotel Committee, C. W. S. Sammelman; Ladies' Advisory Committee, Mrs. B. L. Brown; Ladies' Entertainment Committee, Mrs. W. W. Horner.

No acknowledgment for the St. Louis Meeting would be complete without full credit for the splendid trip of October 4 to visit the immense hydro-electric project at Bagnell, Mo., so ably described in one of the papers of this issue. Transportation, by special train, furnished complete in every detail by the Missouri-Pacific Railroad Company as its contribution to the trip, was sincerely appreciated and everywhere acknowledged. At the dam itself the party of 600 were guests of the Union Electric Light and Power Company and the Stone and Webster Engineering Corporation. The comments on the excellent arrangements and delightful details experienced were frequent. This acknowledgment is due to all those who so cordially cooperated in making the trip a success.

## *Demands for October Issue of Civil Engineering*

Great popularity for the first issue of CIVIL ENGINEERING was anticipated, and to meet it, an additional order for 2,000 extra copies was made at the original printing. But it was not expected that this supply, considered so ample, would be utterly depleted within four or five weeks. This was the case, however, and since early in November the Society has had to plead its inability to furnish copies to answer legitimate demands for the October issue.

It is possible that some members have finished with their copies and do not wish to keep them on file. They may even be willing to contribute the necessary stamps in order that some other engineer may have the opportunity of reading it. Perhaps he is a brand new member and is anxious to learn more about what his Society affiliation will mean to him. Or perhaps it is a library that inquires for it in order to complete its files of the new publication. While the Society does not wish that any member should rob his own files for other legitimate uses it would appreciate any assistance in enabling it to answer these constant inquiries.

## *Innovations for the Annual Meeting*

The 1931 Annual Meeting of the Society will be different. Of course many of its features are governed by Constitutional requirements and customs and will thus have a familiar appearance. However, there are enough changes in the schedule to mark it as an outstanding gathering. One of the most noticeable changes will be found in the program for Wednesday afternoon. This will be a symposium on the Government contributions to engineering knowledge. Few members perhaps realize how much the departments in Washington have to offer of important information that every engineer should have; at least he should know what it is and how he may get it. After Wednesday afternoon's session at the Annual Meeting there will be no excuse.

Practically all the responsible leaders in this work, including Government bureau and department heads, will be on hand. In theatrical parlance, this would be termed a "galaxy of stars." These men will come direct from the firing line and tell engineers many valuable points regarding the manner in which the Government will cooperate. The resulting symposium will fill an oft-noted and long-felt want in engineering knowledge.

At the annual dinner to be held that same evening in the Hotel Roosevelt, a new and different program will be presented. The after-dinner ceremonies will take the nature of official award of Honorary Membership to John R. Freeman. The nature of the exercises will be dignified and in keeping with the high standards of this honor and of the recipient. After these brief exercises, the ballroom will be cleared for the reception of the new President and Honorary Member, to be followed by dancing until the small hours.

Still another unusual attraction is in store for the Smoker on Thursday evening. The lecturer will be none other than Roy Chapman Andrews, celebrated adventurer and scientist. He will tell something of his latest expedition in Central Asia. Fresh from this trip, with pictures that few Americans have been privileged to see, he will give one of his famous talks. It is hard to tell whether a lecture of this sort, or the Smoker to follow it, is responsible for the great popularity of this event, which annually taxes the accommodations of the Engineering Societies Building.

Besides the interesting all-day excursion into nearby New Jersey to study outstanding engineering development, a number of fine trips have also been planned for Saturday, all within easy reach. These are expected to include the new Empire State Building, the Hudson River and Kill van Kull Bridges, and the operating equipment of the Holland Tunnel.

Of course reduced railroad fares will be in effect. Because of the success in past years, it will be possible to obtain the certificate for reduced return rates on identification at the point of departure. No member need therefore take any chance as to the possibility of others failing to cooperate to the desired extent for the certification privilege. It is granted in advance.

Technical features of the usual high order will be found listed in the forthcoming official program. Whether the member is looking for high-class engineering sessions, for delightful social meetings, or just the intimate contact with his fellow members, he will find them all at the Annual Meeting, January 21–24, 1931.

## *A Valuable Study Undertaken*

There was placed in the mails, on December 10th a questionnaire addressed to every member of the Society. The Committee on Engineering Employment in Public and Quasi-Public Offices is making a study of compensation and income secured by engineers in relation to their age, experience, title of position, and service in which employed. The results of a somewhat similar study were published in PROCEEDINGS for January 1921. Needless to say, the passage of the last ten years has rendered this material obsolete except for comparative studies so that it appears desirable to bring these data up to date.

In order to broaden the scope of this investigation and make it more nearly representative, 8,000 additional questionnaires have been struck off on buff paper and are being distributed to the chief engineers of the State highway departments, State departments of health, a small group of counties, and to the chief engineers of the principal cities of the United States, with the request that copies be placed in the hands of engineers in their organizations who are not members of the American Society of Civil Engineers.

The questionnaires are not to be signed nor otherwise identified, with the exception of the above distinction between members and non-members of the Society.

It should not be necessary to point out the value of such a study, which depends very largely on the number of replies received. It is encouraging to know that on December 13 and 14 a total of 470 replies came in.

The analysis of the questionnaire has been undertaken by Arthur Richards, M. Am. Soc. C.E., a member of the Committee on Engineering Employment in Public and Quasi-Public Offices, and any correspondence in connection with it should be addressed to him, at 29 North Dean Avenue, Trenton, N.J.

### BEFORE YOUR AUDIENCE

*The Annual Meeting will afford an opportunity to try out these rules, suggested by the Executive Committee of the Structural Division for use by speakers at all Society gatherings. Speakers before Local Sections may also be interested in these ten points, which are given below.*

*1. Do not read a paper or manuscript; this tends to kill attention and interest. Instead, prepare in advance a well-planned mental outline of what you are going to say, using, if necessary, a memorandum card to recall successive points to the memory.*

*2. Select only the high spots of your subject matter for oral presentation. Material of a mathematical, statistical, or involved nature cannot be effectively presented and should be reserved for the printed publication.*

*3. Plan your opening sentences before you get up to speak.*

*4. Face your audience; look at your audience; speak to your audience.*

*5. Pitch your voice so as to be clearly heard by those in the farthest seats. Avoid a monotone; it is desirable, occasionally, to change the pitch or quality of your voice for emphasis, or to retain attention.*

*6. Be brief. A talk is rarely effective after the first 20 minutes. A discussion should be much briefer, especially when the program is lengthy.*

*7. Relax. Avoid strain in posture or in voice. A touch of natural humor or human interest will add to the effectiveness.*

*8. Use lantern slides or other illustrative material where suitable. In a lantern-slide presentation, it is particularly important to avoid monotony of voice or subject matter, since the accompanying conditions of light and atmosphere are inherently of a soporific nature.*

*9. Be kindly. Avoid self-advertising. Avoid disparagement of others. Treat differences of opinion with courtesy.*

*10. Plan your concluding sentences before you get up to speak. When time limitation prevents completion of all you planned to present, or when lost for things to say, go straight for your conclusion as an effective ending.*

## *Helping a Good Cause*

By and large, the engineer, including the engineer executive, is largely dependent on plant operation, construction, or preparation for construction, for the normal field of his professional operations. It is therefore to be expected, and it is a fact that technical professional men have been, and still are, hard hit by the general slowing down of most plants and the practical stopping of all new construction.

Many of the men who have been chiefly responsible for reduced costs and efficiently operated plants, many of the men who have contributed in a large way to important construction and designs, and many of the men who have visualized far-reaching plans and aided in putting them through, are today idle and thus (although more than willing to do their share toward human progress) are unable to serve humanity at the tasks for which they are best adapted and for which their training and experience especially qualify them.

While little has been published in the way of "calls for help" from this group of the highest type of men, it is certainly not due to any lack of real need. In many cases the need is crucial and imperative.

One of the hopeful developments of recent standing has taken place near Society Headquarters. As is well known, the national engineering societies maintain at all times an employment service. Responsive to the present emergency, a special Volunteer Committee on Employment, under the auspices of the national Engineering Societies Employment Service and consisting of about 15 members of the Four Founder Societies, has been formed in the Metropolitan District. This sub-committee has done some very excellent work by making personal calls on prospective employers nearby, by visiting booths at the Power Show, by sending out about 3,000 letters to prospective employers throughout the country, and by keeping in touch with possible Federal and State work. Doubtless similar committees are at work in other communities.

This Committee, speaking figuratively, is feeling the patient's pulse. According to the latest opinions, it is beginning to recognize signs of incipient recovery. As the Committee reports, it is expected, and apparently quite probable, that the present general depression under which practically all trades, industries, and professions are laboring will soon begin to lessen. In several quarters more optimistic views are being expressed, and in a few cases active preparations for the handling of increased activity in the very near future are being made.

This is indeed encouraging, the Committee believes. Engineers should do everything possible to develop these favorable signs. It feels that the engineer himself can do this and at the same time aid his fellow engineer by maintaining the maximum useful technical staff in his organization, and as soon as conditions permit, by increasing it. This particular period is an unusually good time for acquiring desirable individuals for any organization, individuals whom it would be difficult to find available at other, busier periods. Engineers or specialists of any type, for any particular need, can be supplied effectively by getting in touch with the nearest office of Engineering Societies Employment Service, either in Chicago, San Francisco, or New York.

## *Society Awards Deferred*

The Committee on the Alfred Noble Prize announces that this prize will not be given for the year ending June 30, 1930. It is expected that the award will be made for the first time during 1931. Competing papers are therefore now being received. An inquiry

at the Secretary's office will bring the full information to any one interested.

The 1930 award of the Rudolph Hering Medal has also been deferred. This prize, instituted and endowed in 1924 by the Sanitary Engineering Division, is to be awarded to the author of the paper containing the most valuable contribution of the increase in knowledge in, and to the advancement of, the sanitary branch of the engineering profession.

## *More Members Exempt from Society Dues*

Yearly, as of December 1, bills for Society dues are sent out to all members—or rather, to almost all members. The lucky ones who do not get such reminders are in two classes; either they have paid their dues in advance in a lump sum, or they have acquired exemption by virtue of a long-continued connection with the Society as Corporate Members.

This latter class forms an interesting group, as more names are added each year. About 60 men are included in the current list of those who have achieved this distinction during 1930. Members from all sections of the country and, in fact, from foreign countries as well, will be found in the appended list:

Adams, Edwin Griggs
Ahern, Jeremiah
Allan, Percy
Andersen, Christian

Baker, Elisha Brown
Bauer, Jacob Louis
Beach, Lansing Hoskins
Beardsley, James Wallace
Bennett, Leslie J.
Brooks, John Pascal
Brownell, Ernest Henry
Bush, Lincoln

Chase, Frank Lynton
Chibas, Eduardo Justo
Christy, George Lewis
Claussen, Oscar
Constant, Frank Henry
Corti, Joseph James

Dahm, Sverre
Davis, Arthur Lincoln
Dunn, William Robert

Farquhar, Henry Stilson
Fort, Edwin John
Franklin, Benjamin
Frick, Walter

Goodnough, Xanthus Henry

Hayes, George Samuel
Hazlett, Robert
Hughes, David Edward
Hurry, Edward Henry

Johnson, Lewis E.

Knowles, Morris
Knowlton, Theodore Ely

Lee, Wellington Barnes

Macksey, Henry Vincent
Meem, James Cowan
Meyer, Rudolf
Miller, Clifford Neville
Molitor, Frederic

Nunn, Paul N.

Parmley, Walter Camp

Roberts, William Jackson

Schofield, Hiram Abif
Scofield, Edson Mason
Sibert, William Luther
Sims, Alfred Varley
Smith, Henry Clement

Teilman, Ingvart
Thompson, Sanford Eleazer
Tibbals, George Attwater
Towl, Forrest Milton
Tuska, Gustave Robitscher

Ulrich, Daniel

Waddell, Montgomery
Wall, Edward Everett
Wilgus, William John
Wing, Charles Benjamin

Yereance, William Burnet
York, Herbert Waldo

Each of these men has enjoyed a long and honored connection with the Society. He may have paid dues consecutively for 35 years, or he may have paid for at least 25 years and have reached the age of 70 years during the past year. As such, he is considered by the Constitution to deserve special consideration and be exempt from all further obligations.

## *Making Meetings Available*

The unusual thickness of this special issue of CIVIL ENGINEERING is due to the fact that in it will be found abstracted every paper presented at the Fall Meeting of the Society, held in St. Louis from October 1 to 4, 1930. An unusual opportunity is presented in these Society meetings to bring to a focus new thoughts in engineering. As soon after each meeting as possible, one issue of CIVIL ENGINEERING will be devoted to digests of all the papers presented at the meeting, so that they will be immediately available to readers all over the world. This will be the purpose of the four special issues of CIVIL ENGINEERING each year.

Obviously, to print all the papers in their entirety would require an issue several times more bulky than this one. Condensation serves another purpose also—it saves the busy reader's time. Thus the aim is to present the essential and new ideas of each author in easily readable form while preserving the style of the individual contributor as much as is consistent.

## *Preview of January Proceedings*

At the outset, before the January number is opened, changes will be noticed in the cover. Inside are further changes in the typographic arrangement and appearance of the first few pages. This is 1931 style as applied to the Society's oldest monthly publication.

The changes, such as they are, have little effect on the main body of the book. Probably few members would even notice them except in the early pages. For one thing, the indexes, both for all those papers which have already been printed and are still current as far as discussions are concerned, and for those papers and discussions which appear in the given number, are grouped together where they may be conveniently studied. All the technical contributions, therefore, which are of immediate interest are now listed in consecutive grouping.

Further along in the volume minor changes also may be found. Of these, the principal one relates to the reference to footnotes. In future, the notation in the text will be by means of numbers rather than by distinctive characters; and these numbers will be consecutive throughout the paper and its discussion. Furthermore, the same numbers will be used for notes when the final printing is made in TRANSACTIONS. The resulting arrangement much simplifies the references for readers, and it provides an appreciable economy in the cost of the printing.

Having noted these improvements in style, the member will want to investigate what new papers and subjects the January issue has to offer.

### THE DESIGN OF A REINFORCED CONCRETE SKEW ARCH

Construction work in Westchester County, N.Y., has resulted in the accumulation of a wide variety of engineering data. The activities of the Westchester County Park Commission have been such as to incorporate the most up-to-date elements of such branches of the profession as structural, highway, sanitary, and railway engineering, and regional planning.

"Practical" engineers are sometimes inclined to deprecate the deep delving into mathematics to supply theoretical answers which, to them, seem inapplicable. In the case of arch analysis, for example, designers have heretofore been largely content to build right arches or skewed adaptations of right arches for lack of a working method of applying a more correct theory.

In the January issue of PROCEEDINGS will appear a paper on skew arches by Bernard L. Weiner, Jun. Am. Soc. C.E., who has been engaged for several years in designing skew arches for the Westchester County Park Commission. His results, therefore, will warrant the careful attention of structural designers everywhere.

Arch designers will remember the pioneer work on the theory of skew arches by Prof. J. Charles Rathbun, M. Am. Soc. C.E., published in TRANSACTIONS, 1924, and later supplemented by his tests on plaster models reported in a paper in TRANSACTIONS, 1930, and by other tests on hard-rubber models by Prof. George E. Beggs, M. Am. Soc. C.E., which have not been published. This theory, as originally published in PROCEEDINGS, gave a method for computing the total stresses in a symmetrical, fixed skew arch and

had to be adapted for use in the drafting room. Professor Rathbun, acting as consulting engineer for the Westchester County Park Commission, extended and revised his theory to include both fixed and two-hinged arches and put the theory in such form that influence lines could be obtained. Neither this manuscript (which was never published) nor the original published manuscript took up the problem of proportioning the sections to resist the stresses except in a general way.

PINES BRIDGE ROAD—BRONX RIVER EXTENSION
Clear Span 42 Feet, Skew Angle 42 Degrees

FENNIMORE ROAD SKEW-ARCH BRIDGE
Bronx River Parkway, Westchester County, N.Y.

To present a study of this latter problem is the principal argument for the publication of this paper. It discusses in detail the distribution of the stresses, and develops complete formulas for proportioning skew reinforced-concrete sections, which are illustrated by numerical examples. This work forms Part II of the paper. Even those not interested in arch analysis will find it worth while to read this portion of the paper as a problem in the general mechanics of skewed sections (sections not normal to the sides of the beam).

The author has used Professor Rathbun's theory in the drafting room for some years and has found it necessary to revise the form of the theory in order to facilitate its application. He has also extended it to include unsymmetrical arches of both the fixed and two-hinged type. This study is embodied in Part I, and the application of the theory to a symmetrical two-hinged frame is illustrated by a complete numerical example. Since, in practical design, this work must precede Part II, it has been given first place in the paper although in a sense it is not new, and is not the reason for publishing the paper.

Part III is of special interest to those who design "rigid frames" of the type used so extensively in the Westchester County Park System. It proposes an approximate short cut which greatly reduces the numerical work required for analyzing a structure of the rigid-frame type, as is shown by the illustrative numerical example.

As a whole, the paper furnishes a complete test for the use of designers of skew arches in general. A condensed list of the article headings of Part II will furnish an idea of the value of the paper:

Stress Distribution

Effect of Angle Between Direction of Reinforcing Steel and the Direction of Stress

Derivation of Design Formulas

Having mastered the text, the designer will find all equations necessary for his work conveniently arranged in an appendix at the end of the paper.

### LEGAL PROBLEMS INVOLVED IN ESTABLISHING SET-BACK LINES

In an art such as that of city planning, which requires the active cooperation of so many of the professions, this message from Clifton Williams, Esq., a prominent attorney in the Middle West, should command respectful attention. The paper was read before the Society at the Milwaukee Meeting and a brief preliminary abstract was published in PROCEEDINGS for October 1929. Because of its very evident value in formulating an important problem and raising several new questions, it is submitted now in its entirety for free discussion.

Briefly, Mr. Williams departs from the ordinary concept of a building line as a boundary beyond which new structures may not be built. This problem concerns the establishment of street-widening lines in older districts and he argues his point on the premise that the taking of land for street-widening purposes, if it is necessary for the public good, is a function of sovereignty.

Therefore, Mr. Williams declares that when engineers can establish before the court that a certain street acutely requires widening to avoid great loss of life, through accident or unhealthful crowding, then it should be possible to obtain the power to take and use the necessary land, without compensation. As precedents for this view, examples are cited in which land may be confiscated without compensation to stem the tide of flood, fire, or pestilence for the common good.

### WATER FLOW BY USE OF DIAGRAMS

A concise and interesting paper entitled "A Discharge Diagram for Uniform Flow in Open Channels," by Murray Blanchard, M. Am. Soc. C.E., Hydraulic Engineer, Illinois Division of Waterways, Chicago, Ill., has been built up around discharge measurements on the Chicago Sanitary District Canal made during the years 1914, 1915, and 1916. The diagram consists of a series of "fall" curves referred to discharges as abscissae and work stages as ordinates. The discharge for any observed stage and fall can thus be obtained. Directions for constructing the diagram are given in ten items, and simple computations for solving the equations involved are included.

## *News of Local Sections*

### ARIZONA SECTION

Thirteen members attending the annual meeting of the Section held at the Producers Building in Phoenix, on November 14. A discussion by Past-President Howard Reed of the activities of the Section during 1930 was the opening feature of the meeting. Legislation accomplished included a motion to the effect that the incoming Executive Committee appoint a committee for arrangements for the Society Meeting in Arizona in 1934. The election of officers for the ensuing year resulted as follows: W. E. Dickinson, President; R. G. Baker, First Vice-President; R. A. Hoffman, Second Vice-President; and E. V. Miller, Secretary-Treasurer.

### CENTRAL OHIO SECTION

On November 13, President Bonney called to order the annual meeting of the Section at the Chittenden Hotel, Columbus. After a luncheon, the election of officers for the ensuing year was held,

the results being as follows: President, Lasley Lee; First Vice-President, Robert A. Allton; Second Vice-President, W. H. Knox; Secretary-Treasurer, B. F. Hatch. A report on the work of the local Functional Expansion Program Committee was presented by E. G. Bradbury.

A talk by Robert A. Allton, Sewage Disposal Engineer for Columbus, was the feature of the occasion. He spoke on the subject, "Storm Standby Tanks as Related to Sewage Treatment for Columbus." The attendance numbered 26.

### Cleveland Section

After a luncheon meeting, held by the Section in the Builders Exchange Building, November 13, President Sowers introduced Prof. Clyde T. Morris, who addressed the meeting briefly. The members were informed that George R. Harlow would represent the Cleveland Section at the approaching celebration of the fiftieth anniversary of the founding of the Engineering Society of Western Pennsylvania, to be held in Pittsburgh. The president appointed a Nominating Committee, consisting of Robert Hoffmann, G. H. Tinker, and Wendell P. Brown, to submit nominations for the coming election.

Discussion of the Cleveland Municipal Stadium took up the remainder of the session; Mr. Hoffmann outlined the factors considered important in the location and building of the structure, and Kenneth H. Osborn presented illustrated views of the plans.

A luncheon meeting of the Section was called together by President Sowers on December 10, with 24 members present. At this time President Sowers read a communication from Secretary Seabury regarding the Phebe Hobson Fowler Professional Award, and a motion was made and carried that the Chairman appoint a committee to consider candidates from the Cleveland Section for this award. The Chairman appointed Messrs. Gascoigne and Marsh. After the routine business session, Mr. Harlow gave a brief report upon his attendance at the meeting of the Engineering Society of Western Pennsylvania held in Pittsburgh; and President Sowers reported for Mr. Sabin on the latter's attendance at the St. Louis Convention. The report of the Nominating Committee for Officers for 1931 was given by Mr. Tinker as follows: L. C. Sabin, President; W. E. Pease, Vice-President; and William L. Havens, Secretary.

### Dayton Section

The feature of the regular meeting, held on November 10, was an inspection trip over the railroad grade-crossing elimination project now under construction. Following a luncheon at the Engineers' Club, the party of 34 was conducted over the entire project by city and railroad officials, led by J. D. Moffatt, Chief Engineer of the Dayton Union Railroad Company, and F. O. Eichelberger, City Manager. Guide maps showing the general features of the relocation layout were furnished those in attendance by the City Engineer. Among those attending the luncheon and inspection tour were 13 members of the University of Dayton Student Chapter.

### Georgia Section

A meeting of the Georgia Section was held at the Atlanta Athletic Club on November 10, with Vice-President Whitaker in the chair. There were 28 members and guests present. The business procedure included a discussion by J. Houstoun Johnston of the work of the Functional Expansion Program and the election of Past-President Bates as an Honorary Member of the Section.

At the conclusion of the business session, a motion picture, "Arteries of Industry," was presented, illustrating the manufacture of pipe from the mining of the ore to shipment of the finished product. This film was produced by the National Tube Company, which had sent representatives to the meeting to give additional information concerning its products.

The annual meeting of the Section was held at the Atlanta Athletic Club on December 1, with President Hansell in the chair. Results of the election of officers for 1931 were announced as follows: J. A. Higgs, President; C. C. Whitaker and W. A. Richards, Vice-Presidents; and G. L. Reed, Secretary-Treasurer. The business session included the reading of the report of the American Engineering Council's Committee on Bridge Legislation, which was followed by a spirited discussion. The meeting was attended by 23 members and visitors.

### Iowa Section

Des Moines was the scene of the annual meeting of the Iowa Section, held on November 20. The election of officers for the ensuing year was announced as follows: W. J. Schlick, President; F. A. Nagler, Vice-President; J. R. Maher, Director; and R. B. Kittredge, Secretary-Treasurer. The program for the afternoon included Mr. Kittredge's report on the Cleveland Local Sections Conference; talks by Maurice A. Tanner, President of the University of Iowa Student Chapter, and Francis H. Whitcombe, President of the Iowa State College Student Chapter; and addresses by Prof. F. A. Nagler, of the University of Iowa, and Prof. J. S. Dodds, of Iowa State College.

"Minnesota's Experience as to the Causes and Cures of Frost Damage to Highways" was the subject chosen for an address by C. L. Mott, Assistant Maintenance Engineer of the Minnesota Department of Highways. For years the State of Minnesota has conducted an intensive study of the dreaded spring break-up of low and intermediate types of surfaces and the effect of frost heave on pavements. The problem is now nearing solution, and Mr. Mott had a real message on the subject for Iowa engineers.

### Kansas City Section

At the annual meeting of the Kansas City Section, held December 2, the following officers were announced for 1931: Henry C. Tammen, President; A. N. Reece, First Vice-President; T. J. Strickler, Second Vice-President; and John A. Strang, Secretary-Treasurer.

### Los Angeles Section

At a meeting of the Section called to order by President Barnard on November 3, it was reported that Frank Gillelen and Ralph Reed have accepted appointments to the Central Engineering Committee of the Four Founder Societies in Los Angeles. The Secretary read a communication from Loren W. East thanking the Section for its action in awarding him the Student Chapter prize. A canvass of ballots for the nomination of officers for the Section resulted as follows; Robert Linton, President; O. A. Stone, Vice-President; and H. Macy Jones, Secretary. President Barnard reported that, in accordance with Secretary Seabury's request, he had appointed Frank L. Olmsted, of the California Institute of Technology, and Harry Dennis, of the University of Southern California, to serve as contact men for each of the Student Chapters.

On November 19, the Sanitary Group of the Los Angeles Section met at the Engineering Club, with 23 members and guests present. The results of the election of officers for 1931 were reported as follows: Alva J. Smith, Chairman; R. F. Goudey, Vice-Chairman; and Marion L. Crist, Secretary. The entertainment features of the meeting were addresses by R. B. Thieme, of the International Filter Company, and F. A. Batty, of the Los Angeles Bureau of Engineering. The Salinas Activated Sludge Plant was discussed by Chester Smith, while A. J. Smith spoke on the Escondido plant.

On December 3 members of the Section enjoyed a trip to the big Tujunga Dam now under construction by the Los Angeles County Flood Control District. This inspection trip was made possible by the courtesy of E. Court Eaton, Chief Engineer of the Flood Control District, and the E. L. Dixon Company, Contractors.

At the annual meeting of the Section, on December 10, held at the Engineers' Club, 70 members and 10 guests were present. Among the speakers were: Major W. H. Lanagan, Corps of Engineers, U.S.A., who briefly sketched the work of the Corps in river, harbor, and flood control work from 1824 to the present time, and George F. Nicholson, Harbor Engineer of Los Angeles, who spoke on the development of Los Angeles Harbor by the city. The latter's remarks were illustrated by a moving picture. Installation of officers, nominated at the meeting of November 3, took place; and, at the same time A. L. Sonderegger was made Senior Vice-President and Merrill Butler, Treasurer.

### Maryland Section

A meeting of the Maryland Section, held November 12 at the Engineers' Club, was addressed by C. E. Keefer, Engineer of Sewage Disposal of Baltimore, on the subject of sewage treatment in Europe. The talk was illustrated by slides made from photographs of the forty-odd disposal plants that Mr. Keefer visited.

To discuss ways and means of holding the interest of Juniors in

the Society was the purpose of a meeting of the Section held November 24. Special steps taken to achieve that purpose included the appointment of a committee to establish contacts between Junior residents of Baltimore and the Section, and provision for creating a prize of $25 for the best paper upon a given subject or topic.

### Miami Section

In the absence of President Sandquist, Past-President R. W. Reed took the chair at a dinner meeting of the Section held at the McAllister Hotel, November 20. A film, entitled "Hydro-Electric Power Production in the New South," was shown through the courtesy of the E. I. du Pont de Nemours Company, and was enjoyed by those present.

### Mid-South Section

On September 19, the regular quarterly meeting of the Board of Direction of the Section was held in Memphis, with President Garver, Vice-Presidents Reinecke, Miller, and Hidinger, and Secretary Markwell in attendance. At the request of the Society, a local committee, consisting of J. R. Fordyce, G. W. Miller, and H. S. Gladfelter, was appointed to cooperate with the Functional Expansion Committee. The Board of Direction then appointed H. A. Wiersema observer at the meetings of the Mississippi Valley Association, and it appointed a Membership Committee, to consist of A. C. Gault, H. N. Howe, and C. H. West.

Despite extremely inclement weather, 51 members attended the regular fall meeting of the Section, held at Greenville, Miss., on November 14. Following the business session, Mayor Schelben gave the address of welcome, after which Lieut.-Col. F. B. Wilby, in charge of the Memphis Engineer District, spoke on "Modern Aspects of Military Engineering." Another enjoyable feature of the occasion was an illustrated lecture by Major T. B. Larkin, Assistant Engineer of the Vicksburg Engineer District, on the subject of "Flood Control Works in the Vicinity of Greenville." The lecture covered an outline of the adopted plan and a technical consideration of the problems of levee building.

The members were then taken on an inspection trip by Lieut. Morris W. Gilland, engineer in charge of the work, to see the levees described in the lecture. Following this, the new plant and products of the Greenville Insulating Board Corporation were examined through the courtesy of the local superintendent, Mr. Mayhall. The Rev. J. W. Young was the principal speaker at the evening banquet.

### Milwaukee Section

President Whitney called to order a meeting of the Section at the City Club, October 30, with 16 members in attendance. T. C. Hatton reported on the progress made on a proposed legislative bill for the registration of engineers, and Prof. E. D. Roberts was appointed a member of the Legislative Committee. Secretary Ullius reported on his trip as delegate to the Cleveland Convention and described the Cleveland Union Terminals Project, which was one of the feature topics of discussion at the Convention.

### Northeastern Section

At the meeting of the Section held at the Engineers' Club, Boston, on November 6, the keynote of discussion was the engineer's place in Army activities. The duties of the U.S. Corps of Engineers was the subject of the address by Maj.-Gen. Lytle Brown; members found of particular interest his statement that Government appropriations are now made to permit the Corps of Engineers to engage consulting engineers, and that one member of the Society, Prof. Charles M. Allen, of Worcester Polytechnic Institute, has already been employed as a consultant by the Corps.

At the business session of the meeting, the following were appointed a Nominating Committee: Gen. Richard K. Hale, Col. Lewis E. Moore, Frank E. Winsor, Francis H. Kingsbury, and Prof. Dwight Porter. There were 53 members and 6 guests present.

### Northwestern Section

The St. Paul Athletic Club was the scene of a dinner meeting of the Section, held November 21, with 37 members and guests in attendance. The subject of the Hastings Lock and Dam, recently constructed on the Mississippi below St. Paul, was covered by three speakers: Lieut.-Col. Wildurr Willing, District Engineer, U.S.A., C. R. Conkey, and Mr. Hill, the remarks of the latter being illustrated by motion pictures. Francis C. Shenehon then paid tribute to the work of John R. Freeman, Past-President of the Society, whose activities in the field of model testing culminated in the establishment of the National Hydraulic Laboratory.

Further discussion of model results as they bear on the design and action of the adopted stilling basin was contributed by Adolph Meyer. Dr. Lorenz G. Straub, who held the Freeman traveling scholarship in 1927, spoke of the extensive use made of models in Europe, and J. A. Childs, Chief Engineer of the Metropolitan Drainage Commission, pointed out the results of experimentation with the stilling basin in the St. Paul-Minneapolis section of the Mississippi.

### Philadelphia Section

A joint meeting of the Section and the Engineers' Club of Philadelphia was held November 20. "City Traffic Problems and Their Remedies" was the subject of the meeting, and the wide interest in this subject was attested by the attendance of 330 at the meeting and 187 at the dinner. Addresses on various phases of the problem were given by Leslie J. Sorensen, Traffic Engineer of Chicago; Carl W. Stocks, Editor of *Bus Transportation;* Dean J. Locke, Research Engineer, United Electric Railway Company; Ernest P. Goodrich, Consulting Engineer of New York City; C. W. Stark, Assistant Manager, Transportation and Communication Department, Federal Chamber of Commerce; Hawley S. Simpson, Research Engineer; Franklin M. Kreml, Director, Accident Prevention Bureau, Evanston, Ill.; and Maxwell Halsey, State Traffic Engineer of Massachusetts. Added interest was given the occasion by the presentation of a film illustrating a "Steadyflow" traffic system. This was shown through the courtesy of Fritz Malcher, Austrian engineer.

The Section has been obliged to accept with regret the resignation of George H. Shaw, Secretary-Treasurer of the Section for the past six years, who has accepted a position with the Bureau of Animal Industry, U.S. Department of Agriculture. Charles A. Howland, Staff Engineer of the Philadelphia Bureau of Municipal Research, has been elected Secretary-Treasurer to succeed Mr. Shaw.

### Providence Section

A joint meeting of the Section with the local section of the American Society of Mechanical Engineers, and with the Municipal Section of the Providence Engineering Society, was held November 6 in the Engineering Society rooms. The chief speaker was Frank W. Skinner, Consulting Engineer of New York City, his subject being "The Great Hudson River Bridge and Comparative Spans." The talk, which was illustrated by lantern slides, included a brief résumé of the general development of suspension bridges, with specific reference to such features of the Hudson River Bridge as the foundations, towers, anchorage, equipment methods, and the spinning of the 28,000 tons of cable.

### Sacramento Section

Thirty-two members attended the weekly luncheon meeting of the Section on October 14 and were addressed by J. B. Lillard, President of Sacramento Junior College. Other luncheon meetings were held October 21 and 28, the attendance of members and their guests numbering 40 and 45, respectively. The first meeting was addressed by the Rev. Lawrence Wilson, and the latter by Gen. Wallace Mason, of the National Guard, who spoke on the "History of Company A, California Engineers."

Motion pictures showing construction of the Cascade Tunnel, prepared by the Du Pont Company, and of the Transatlantic Telephone, made by the Pacific Telephone and Telegraph Company, were shown to the 40 members and guests present at the weekly luncheon of November 18. The death of Thomas G. Gerdine, a member of the Section since its organization, was announced. Other meetings were held November 25 and December 2, the speaker for the former being A. E. Fingado and for the latter Fred C. Scobey.

### Tacoma Section

The feature of the November 10 meeting of the Section was an address by Llewellyn Evans, Superintendent of the Light Department of the City of Tacoma, his subject being the recession of Nisqually Glacier on Mount Tacoma. Mr. Evans has made many observations and pictures of the glacier. Thirty-three members and their wives were in attendance.

# ITEMS OF INTEREST

*Engineering Events in Brief*

## Art by Engineers

HISTORY recalls an astonishing number of great engineers who have also been great artists. The Fifty-first Annual Meeting of the American Society of Mechanical Engineers, recently held at the Engineering Societies Building in New York, gathered together an art exhibition consisting entirely of the amateur work of engineers. The 200 exhibits displayed remarkable technical ability as well as real delicacy of artistic feeling.

Even in their art, the versatility of the engineers was shown in the varying mediums of expression used—sculpture, wood carving, sketches in crayon, oil and watercolor painting, photography, etching, and book plates.

"The Mighty City," the bromoil photograph chosen for reproduction on the feature page, in the front of this issue, seems particularly to epitomize the spirit of modern municipal growth that formed the feature topic of the Technical Meeting of this Society's Fall Meeting at St. Louis. "The Mighty City" is the work of George H. Morse, Member American Institute of Mining Engineers, and General Superintendent, Northern Coal Mines, Republic Iron and Steel Company, Pittsburgh, Pa. The warmth of the original has suffered in the processes of reproduction, but the enjoyment of the page may be increased by viewing it at a distance.

Members of the civil engineering field contributed to the exhibit as well. H. L. Doolittle, M. Am. Soc. C.E., displayed six etchings, while C. E. Grunsky, Past-President of the Society, has used oil and watercolor in his artistic avocation. P. G. Laurson, M. Am. Soc. C.E., exhibited an oil painting. Other practicing civil engineers who contributed to the exhibition were R. L. Sackett and Augustus Smith, Members Am. Soc. C.E. The work of the former comprises watercolors and oil paintings of various European scenes and that of the latter an oil painting of a California landscape.

That the versatility of engineers has found expression in music as well as in art was evidenced by the high quality of the entertainment provided for the opening session of the meeting. Upon that occasion a trio of bridge engineers presented a program of classical and romantic music. The famous trio consists of John E. Greiner, violinist, Otis E. Hovey, flutist, and Ralph Modjeski, pianist, all Members Am. Soc. C.E.

## Underground Pipe Protection Institute

MANY engineers, especially those entrusted with the operation and maintenance of underground pipe lines, are continually faced with the difficulties of protecting their conduits against corrosion. Much has been written on this vital subject, but many invaluable experiences have never been recorded.

A recent organization, the Underground Pipe Protection Institute, has as its purpose a comprehensive study of the corrosion problem. Through cooperation with individuals and other technical organizations, it proposes to unify all available knowledge in its field.

Engineers faced with pipe-corrosion problems may find ready assistance through the new organization and should address their inquiries to the Institute, Room 1737, 17 Battery Place, New York, N.Y.

## COMING EVENTS

AMERICAN SOCIETY OF CIVIL ENGINEERS

*Annual Meeting Convenes in New York*

January 21, 22, 23, 1931

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
Winter Convention will be held in New York, January 26–30, 1931.

AMERICAN ROAD BUILDERS ASSOCIATION
Annual Convention and Road Show will take place in St. Louis, January 12–16.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS
Thirty-seventh Annual Meeting will be held in Pittsburgh, January 26–29.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA
Annual Meeting is to be held in San Francisco, January 25–28.

MIDWEST POWER ENGINEERING CONFERENCE
The Conference will assemble in Chicago, February 10–13.

NATIONAL CRUSHED STONE ASSOCIATION
Annual Convention will be held in St. Louis, January 19–22.

NATIONAL PAVING BRICK MANUFACTURERS ASSOCIATION
Twenty-fifth Annual Meeting is to be held in Pittsburgh, February 4–6.

NATIONAL READY MIXED CONCRETE ASSOCIATION
First Annual Convention and exhibit will be held in St. Louis, January 26, at the New Hotel Jefferson.

NATIONAL SAND AND GRAVEL ASSOCIATION
Annual Convention is scheduled for January 27–29, in St. Louis.

THE SOCIETY OF AUTOMOTIVE ENGINEERS
Annual dinner will be held in New York on January 8; annual meeting will be held in Detroit, January 19–23.

## Engineering Abstracts for 1931

ATTENTION is again called to the economical arrangement between the Society and the Institution of Civil Engineers in London whereby members may purchase the Engineering Abstracts of the Institution at a nominal price. The arrangement, now in effect for almost two years, permits any member of the Society in good standing to subscribe for a given year at the rate of \$5.00, including postage.

No engineer who is familiar with engineering literature on the continent needs any recommendation for this publication. It gives in concentrated form the essence of all the major articles appearing in periodical literature throughout the world affecting the various main fields of engineering. These articles are abstracted by acknowledged experts, specially chosen by the Institution. They give more than an outline of the paper; the important facts and deductions are explicitly stated. The reader finds not only the general trend of the argument but the definite results in condensed form.

Usually the first quarterly issue of these abstracts reaches America by the middle of February. This means that subscriptions placed now will be in time to obtain the advantages of the full series for 1931. Doubtless many members will avail themselves of this courteous cooperation on the part of the Institution of Civil Engineers. Subscriptions are payable in advance and should be forwarded to the Institution at its London office, Great George Street, Westminster, S. W. 1, London, England.

## Development of Mississippi River Flood Control

AT ITS RECENT meeting, the American Engineering Council took up again the important topic of Mississippi River flood control, and after listening to a report of its Flood Control Committee, it adopted the following resolution:

"*Be it resolved by the Administrative Board of American Engineering Council,* That this body adheres to the opinion heretofore expressed that so much is involved in the Mississippi River flood control project, that before final commitment to the major engineering features of the project is made, the Chief of Engineers of the Army should have the benefit of the counsel of the best hydraulic engineering talent that the Nation affords. In its judgment, some of the present expenditures, even though warranted as partial protection, may not be effective in the plan finally adopted."

It was reported that surveys and studies are now being made by the War Department

more nearly commensurate with the importance of the subject than those previously attempted. Because of the importance of such studies, it was urged that Congress allow ample time for the Chief of Engineers to perfect his preliminaries before committing himself to the general plan of flood relief.

In doing so, the Council further emphasized the fact that there are not only engineering problems to be solved, but also economic problems. Investigation may show that the value of some tracts of land does not justify large expenditures for flood protection but that such lands should be taken over for reforestation under existing Federal laws.

## The Missing 10 Per Cent

A VOCATIONAL analysis of the membership of the Society recently completed discloses some striking facts. Based on the membership record of the 14,482 members as of June 30, 1930, one-half are owners of, partners in, or employees of companies or corporations of one kind or another. About 1,800 are classified as consulting engineers and over 3,000 earn their remuneration in the employ of the United States and of the various State, county, and municipal governments. Of this total list, 5 per cent are classified as educators, while the data from over 9 per cent were too meager for classification.

This list includes the President of the United States; two State governors; 57 State engineers or deputies; 54 city managers; 271 city engineers; 76 university presidents, deans, and department heads; 30 editors; 8 lawyers; 51 electrical, mechanical, or mining engineers; 84 architects; 202 Army and Navy engineers; 33 railroad presidents, directors, and chairmen of boards; 124 industrial corporation presidents, directors, and chairmen of boards; 19 public utility presidents and directors; 256 owners or presidents of engineering and construction companies; and 736 partners, owners, or presidents of consulting engineering companies.

Attention should be focused on one factor, and this is not what the tabulation shows but what it fails to show. Almost 10 per cent of the members could not be classified.

To put it another way, members had not informed the Society of their business affiliation even by name; and so the classification in so far as those particular members were concerned had to go by default. It is doubtful if these men had many legitimate reasons for concealing their connections. They simply did not think that anyone would be particularly interested. However, the Society is interested in every member, including the contribution that he makes to the professional status of the entire group.

Certainly, a perusal of the analysis will show much to make any member proud. Perhaps even the missing 10 per cent will wish they could have been included in the specific tabulation. There is a way in which this can be done—by including the necessary information on the card for use in the 1931 Year Book. Every member can help in this way to make our accountability 100 per cent.

Then there is still another way that is at times even more useful. This is in connection with the file of professional records kept at Headquarters. Many members have failed to appreciate the value to them of being listed in such a file. Frequently members whose names appear there benefit from information which can be given to inquirers regarding their experience and ability. If you are among the uncounted, a postcard memo to Headquarters will enable you to escape from the list of missing men.

## What Our Members Do

RESULTS of analysis of the Society membership list by the Advertising Department show the following interesting subdivisions:

*Analysis by Fields of Work*

| | Per Cent | Per Cent |
|---|---|---|
| Engineering and construction companies | | |
| Consulting engineering companies | 21.5 | |
| Engineering and construction companies | 13.4 | 34.9 |
| Public utilities—power and light | | 2.8 |
| Water supply (other than governmental) | | 2.3 |
| Industrial and commercial corporation officials and engineers | | |
| Industrial corporations | 8.5 | |
| Railroads | 6.0 | |
| Iron and steel companies | 3.6 | |
| Petroleum companies and independent producers | 1.5 | |
| Commercial companies | 2.8 | 22.4 |
| Governmental officials and engineers | | |
| Federal | 5.7 | |
| State | 5.6 | |
| County | 2.0 | |
| Municipal | 8.9 | 22.2 |
| Educators | | 4.7 |
| Miscellaneous | | 1.5 |
| To be classified | | 9.2 |
| Total | | 100.0 |

*Analysis by Position*

| | | |
|---|---|---|
| Company and corporation officials | | |
| Owners, partners | 4.5 | |
| Presidents, directors, chairmen of boards | 4.6 | |
| Vice-presidents, secretaries, treasurers, general managers | 6.3 | |
| Chief Engineers | 3.8 | |
| Assistant chiefs, division and department heads | 14.7 | |
| Engineers | 10.9 | |
| Assistant Engineers | 5.4 | 50.2 |
| Consulting Engineers | | 12.6 |
| Governmental Engineers | | |
| Federal | 5.7 | |
| State | 5.6 | |
| County | 2.0 | |
| Municipal | 8.9 | 22.2 |
| Educators | | 4.7 |
| Miscellaneous | | 1.1 |
| Unclassified | | 9.2 |
| Total | | 100.0 |

## The Earth's Interior

AT FIRST thought it seems a hopeless task to ascertain anything about the interior of the earth. And yet, developments in various branches of science during the last decade permit us now to form a fairly satisfactory notion of what the interior is like. The complete account of how this is done reads like a detective story—as indeed do many of the tales of scientific achievement. Various clues and

ts of evidence are pieced together and ally the mystery is unraveled.

The most fruitful source of information has been data obtained by seismologists, especially when combined with the results of laboratory measurements on rocks and minerals. Earthquakes of any considerable magnitude produce elastic waves, some of which travel along the surface while others pass through the body of the earth and may be recorded by a seismograph anywhere on the globe.

The waves, emerging at the given station, bear with them a message telling how long they have been on the way, how deep they have penetrated into the earth, and exactly how fast has been their speed at all points of their path. True, these messages are in code, but by a very ingenious mathematical analysis they may be deciphered. Of particular interest is the conclusion that near the surface the velocity of one type of through-waves (the longitudinal ones) is 3.3 miles per second, and that at about 30 miles depth the velocity suddenly changes to 6.4 miles per second.

With this valuable aid from the seismologist and the mathematician, we now turn to the physicist who provides us with measurements on the elastic properties of typical rocks and minerals. These measurements are obtained with a high-pressure apparatus capable of developing 12,000 atmospheres hydrostatic pressure, and are of importance because, from the elastic constants, we can readily calculate the velocity with which longitudinal vibrations will pass through the several kinds of rock. By comparing these results with the known velocities at various depths as determined from seismologic data and noting which velocities match, we are able to determine the kind of rock which exists at any given depth. In this way we find, for example, that the outermost ten miles consist almost entirely of granite.

It has long been known that the average density of the earth is 5.5. Since the density of surface rocks is about 2.7, it follows that somewhere within the earth there must be some heavier material. Indeed, to make the average come out right, we should expect that at the center the density would be 8 or 10. Now this high density may be caused either (1) by the diminution in volume of ordinary rocks under the enormous pressures in the interior (3,000,000 atmospheres at the center), or (2) by the presence of some intrinsically heavier material. The first of these possibilities has been ruled out by a careful investigation; therefore it is concluded that there is a central core of some heavy substance which, from its abundance in the sun and stars and in meteorites, is almost certainly iron. Here again we must omit the details of the way in which physics, chemistry, seismology, mathematics, and cosmogony have been called to the aid of geophysics.

Neglecting the relatively thin film of sedimentary rocks at the surface, there is first a layer of granite 10 miles thick; below that a layer of basaltic rocks 20 miles thick; then 2,000 miles of peridotite, a rock rare at the surface, consisting of iron magnesium silicate; and finally a central core 4,000 miles in diameter of metallic iron with a little nickel. Perhaps the most striking feature of the composition of the whole earth is that our globe is made up almost entirely of four elements: iron, magnesium, silicon, and oxygen; the remaining 88 possible elements are confined to the thin film called the crust.

*From Research Narratives, Engineering Foundation, Inc. Leason H. Adams, Carnegie Institution of Washington, Washington, D.C.*

## Freeman Scholar Reports

THIS YEAR THE Freeman Fund traveling scholarship to study hydraulic laboratory practice in Germany and other European countries was awarded to Hans Kramer, Assoc. M. Am. Soc. C.E. Lieutenant

Outdoor Station at Marquardt

The Berlin Laboratory

PRUSSIAN EXPERIMENT INSTITUTE FOR HYDRAULIC ENGINEERING AND SHIPBUILDING

Kramer has been spending a number of months investigating laboratory facilities in Germany and Switzerland and upon his return to Berlin, about December 15, he probably will participate in some of the current experiments at the Prussian Experiment Institute for Hydraulic Engineering and Shipbuilding. This institute has both a main laboratory at Berlin and an outdoor station at Marquardt, 30 kilometers distant. This is one of the stations described by Dr. John R. Freeman, Hon. M. Am. Soc. C.E., in his *Hydraulic Laboratory Practice.*

## Boundary Oddities in U.S.G.S. Bulletin

BULLETIN 817, just issued by the U.S. Geological Survey, is the work of Edward M. Douglas, who gives in its 265 pages, "boundaries, areas, geographic centers, and altitudes of the United States and the several States."

According to the Survey, the peculiar irregularities of some of the State boundaries are due to compromises made to adjust differences between the representatives of the States. The "Southwick Jog," for example, which appears on the boundary between Connecticut and Massachusetts was established because, in adjusting errors in the boundary as previously run by compass, a long, narrow strip of land was given to Connecticut, and the jog ceded to Massachusetts was intended to be an equivalent area. The panhandle at the southeast corner of Missouri is said to be the result of efforts of a prominent landowner to have his plantation included in the new State. The projection on the northern boundary of Minnesota, which includes a land area of about 124 sq. miles, separated from the main part of Minnesota by the Lake of the Woods, resulted from the use of inaccurate maps by the treaty makers and has been described as a "politico-geographical curiosity of a boundary that a glance at the map will show, that no one could have foreseen, and that would be inexplicable without some knowledge of the steps in the process by which it was brought about."

Probably the most widely known boundary in the United States is the "Mason and Dixon Line" between Pennsylvania and Maryland, run by two famous English mathematicians from 1763 to 1767. Their work was stopped by Indians, but they had run from the Delaware River to a point about 30 miles beyond the northwest corner of Maryland. The accuracy of their survey is shown by the fact that in a resurvey 130 years later, with modern instruments and methods, the position found for the northeast corner of Maryland differed only 180 ft. from their position. The original stones for 5-mile marks on this line were carved in England from limestone and are still standing, with Lord Baltimore's coat of arms on the Maryland side and the Penn arms on the Pennsylvania side.

The east-west part of the boundary between Massachusetts and Rhode Island was for more than 200 years a matter of dispute, and was in some respects the most remarkable boundary question with which this country has had to deal. Twice the question went to the Supreme Court of the United States, and in one of these suits Daniel Webster and Rufus Choate were employed as counsel for Massachusetts. Choate, to illustrate the indefiniteness of certain boundary lines, said before the Massachusetts Legislature:

"The commissioners might as well have decided that the line between the States was bounded on the north by a bramble bush, on the south by a blue jay, on the west by a hive of bees in swarming time, and on the east by 500 foxes with fire brands tied to their tails."

This bulletin, with its wealth of pertinent facts of interest to every engineer, and containing numerous maps and illustrations, may be obtained from the Superintendent of Documents, Washington, D. C., for 50 cents.

## Lincoln Electric Company's Welding Prize

APPROXIMATELY six weeks ago, the Second Lincoln Arc-Welding Prize Competition was announced. This competition is designed to stimulate designers and engineers in every line of industry to consider the application of arc welding to the manufacture of their own product, and carries prizes totaling $17,500, divided into 41 separate awards. The contest closes October 1, 1931, and is open to any one in the world except employees of the sponsoring company.

Additional information may be obtained by addressing the Lincoln Electric Company, P. O. Box 683, Cleveland, Ohio.

## Outstanding Engineers

THE Society for the Promotion of Engineering Education recently asked officials of the various American engineering schools to point out the men who have, in their estimation, been the outstanding engineers of the past 25 years; also those who might fairly be considered the greatest engineers of all time. A generous response came in and the list, as published in the November *Journal of Engineering Education*, is reproduced here.

GREATEST ENGINEERS OF ALL TIME

(*78 Names Mentioned*)

James Watt
Leonardo da Vinci
Thomas A. Edison
James B. Eads
Ferdinand de Lesseps
Charles P. Steinmetz
George Westinghouse
John Ericsson
Archimedes
Lord Kelvin
John L. Roebling
George W. Goethals
John F. Stevens

OUTSTANDING ENGINEERS OF THE PAST 25 YEARS

(*71 Names Mentioned*)

Herbert C. Hoover
Charles P. Steinmetz
Thomas A. Edison
John F. Stevens
John Hays Hammond
George W. Goethals
George Westinghouse
Guglielmo Marconi
Henry Ford
Ralph Modjeski
Benjamin G. Lamme
Michael Pupin
John R. Freeman
Clemens Herschel
Gustav Lindenthal

It is of interest to note that, among the 15 comprising the group, 8 can be classed as civil or mining engineers. Of those still alive, all but one are Honorary Members of the Society.

## NEWS OF ENGINEERS

WENDELL M. REED has become Special Irrigation Engineer for the U.S. Indian Service, for which he was previously Supervising Engineer. He is now located in the Lewis Building, Los Angeles.

R. U. ST. JOHN, formerly District Engineer with the Standard Oil Company, Sacramento, Calif., is now Manager of the San Francisco Bay Airdrome, Webster St., Alameda.

R. ROBINSON ROWE, who has been with the Tom T. Allen Company, San Diego, has become a partner in the firm, the name of which has been changed to Allen and Rowe, Civil Engineers.

EDWIN L. STRANDBERG, Structural Engineer, of Seattle, Wash., has gone into partnership with William Rueter under the firm name of Strandberg and Rueter, Structural Engineers.

CHARLES R. MCNIECE, formerly Property Manager for the William Taylor Son and Company, Cleveland, is now with the E. F. Hauserman Company, also of Cleveland.

ROBERT L. WING has been appointed Assistant Hydraulic Engineer of the State of California, Division of Water Resources, Sacramento.

CARL F. RENZ, formerly Computer with the Harold G. Ferguson Engineering Corporation, Los Angeles, has been made Assistant Testing Engineer of the Los Angeles County Flood Control District, Alhambra, Calif.

CLARK L. WHITE is now Engineer with the McClintic-Marshall Company, Pittsburgh. He had been previously connected with the Riter-Conley Company of the same city.

VERNON G. WATTERS, Engineer of Savannah, is now Assistant Secretary of the Florida Industrial Company, Lake Placid, Fla.

EUGENE SOMERS has left Northampton, Pa., where he was Chief Draftsman with the Universal Atlas Cement Company, to take up his work as Chief Engineer for the Bessemer Cement Corporation of Youngstown, Ohio.

RENÉ M. GENTHON has accepted a position as Resident Engineer for George A. Johnson of 150 Nassau Street, New York.

D. M. FORESTER has been promoted to Chief Engineer of the Moscow Office of the Seabrook Engineering Corporation, with headquarters in the Hotel Savoy, Moscow, U.S.S.R. He was formerly Engineer for Low-Cost Roads with the same company and working with Obldortrans, the Moscow State highway department.

H. ELTINGE BREED, Consulting Engineer, JAMES L. KEHOE, Asphalt Engineer, and A. W. KINNEY, Engineer for Bituminous Macadam, with the Seabrook Engineering Corporation in Russia, have returned to the United States for the winter.

E. C. LARUE and B. F. JAKOBSEN, Consulting Engineers of Los Angeles, Calif., have dissolved their partnership. Both will, however, continue to practice, Mr. LaRue specializing in water supply and storage problems, and Mr. Jakobsen in dam design and flood control.

EVERITT W. WILSON, formerly foreign representative for the J. G. White Engineering Corporation of New York, N.Y., is now associated with Winston Brothers Company, Minneapolis, Minn., as representative for the negotiation of contracts outside of the United States.

WALTER C. GROVES, formerly Valuation Engineer of the Donora Southern Railroad, Donora, Pa., has been promoted to Chief Engineer of the same company.

JOSEPH A. DUNN, who was Chief Engineer of the American Hume Concrete Pipe Company with headquarters in Detroit, Mich., has been transferred to Swampscott, Mass., where he is General Manager of the Hume Pipe of N. E., Inc.

WARNER HARWOOD has left Consoer, Older, and Quinlan of Madison, Wis., and is now General Supervisor of the Cook County Highway Department with headquarters in Chicago, Ill.

W. HENRY KLYCE, JR., now Sales Manager of the Sanivac Sales Company, was formerly Sales Engineer for the Flint Structural Steel Company of Flint, Mich.

H. W. KNOX is now engineer for the E. O. Roberts Company, Inc., of New York, N.Y., having left the Toledo office of Wardell and Hardesty, Consulting Engineers.

LEROY F. KRUSI has left the Standard Oil Company of California and is now Vice-President of the Taper Tube Pole Company of San Francisco, Calif.

WILLIAM T. IVEY is now associated with the Alabama Natural Gas Corporation with headquarters in Birmingham, Ala.

FRANCIS A. LANDRIEU, who has been Design Draftsman, U.S. Naval Operating Base, Public Roads Department, Hampton Roads, Va., has accepted a position as Structural Designer with the Board of Commissioners of the Port of New Orleans, with headquarters in New Orleans, La.

KENNETH H. OAKLEY has left the Nickel Plate Railroad, Cleveland, Ohio, and is now a Designer for the Advisory Subway Commission of Chicago, Ill.

HAROLD A. RANDS has left the Canadian Crown—Willamette Paper Company of Portland, Ore., and has accepted an engagement with the War Department as Hydroelectric Engineer, with headquarters at 315 Custom House, Portland, Ore.

WALTER F. SHATTUCK, JR., is Assistant Superintendent for Starrett Brothers, Inc., whose office is at Carew Tower, Cincinnati, Ohio.

ALBERT P. GREENSFELDER of St. Louis, Mo., and WILLIAM A. STARRETT of New York, N.Y., have been nominated by the Associated General Contractors of America for President and Vice-President, respectively, of the organization. Elections are to be announced at the Annual Meeting of the organization, to be held at San Francisco, January 25, 1931.

# Changes in Membership Grades

## *Additions, Transfers, Reinstatements, Deaths, and Resignations*

From November 11 to December 10, 1930

### Additions to Membership

Allen, Edward Lucius. (Assoc. M., Nov. '30.) 144 East Henry St., Spartanburg, S.C.

Amirikian, Arsham. (Assoc. M., Nov. '30.) Associate Structural Engr., Navy Dept., Bureau of Yards and Docks, Washington, D.C.

Argetsinger, John Deem. (Jun., Nov. '30.) 101 Canfield Ave., West, Detroit, Mich.

Arny, Robert Allen. (Jun., Nov. '30.) 135 Watchung Ave., Montclair, N.J.

Austin, John Corneby Wilson. (M., Nov. '30.) Archt., John C. Austin and Frederic M. Ashley, Suite 608, Chamber of Commerce Bldg., Los Angeles, Calif.

Bailey, Kenneth McGrath. (Assoc. M., June '30.) 375 Millaudon St., New Orleans, La.

Bain, Joseph Albert. (Jun., Nov. '30.) Box 43, Nahunta, Ga.

Banks, Harvey Oren. (Jun., Nov. '30.) Instr., Civ. Eng., Stanford Univ., Box 1104, Stanford University, Calif.

Barton, Jason Edward. (Jun., Oct. '30.) With Bureau of Bridges, State Highway Dept., 815 East High St., Jefferson City, Mo.

Berryman, William Charles. (Jun., Nov. '30.) Box 265, Ewen, Mich.

Bland, Richard Louis. (Assoc. M., Nov. '30.) Civ. and Exploration Engr., 833 South Spring St., Los Angeles, Calif.

Block, Herman Henry. (Assoc. M., Nov. '30.) Care, Fargo Eng. Co., 120 West Michigan Ave., Jackson, Mich.

Boehm, Edward Cosmos. (M., Nov. '30.) Pres., Boehm Bros., Inc.; Vice-Pres., Erie Equity Owners, Inc., 239 Colorado Ave., Buffalo, N.Y.

Bohrmann, Henry Rudolph. (Jun., Nov. '30.) South Colton, N.Y.

Bonnell, Ralph Arnold, Jr. (Jun., Oct. '30.) Hardin, Ill.

Brechka, Frank August. (Jun., Nov. '30.) Junior Engr., New York and Queens Elec. Light and Power Co., Flushing, N.Y.

Brett, Thomas Bronson. (Jun., Oct. '30.) Care, U.S. Engr. Office, Vicksburg, Miss.

Brown, George Arthur. (Assoc. M., Nov. '30.) Sales Engr., Lehigh Stone Co., Kankakee, Ill.

Brush, Gorton William. (Assoc. M., June '30.) Structural Engr., Allied Engrs., Inc., Jackson, Mich.

Buhler, Fred William. (Jun., Nov. '30.) 8787 116th St., Richmond Hill, N.Y.

Burke, James Laurence. (Assoc. M., Nov. '30.) 14 Highland Ave., Yonkers, N.Y.

Cahill, Cato George. (Assoc. M., Nov. '30.) Asst. Engr., Bureau of Eng., City of Los Angeles, Calif.

Carberry, Deane Edwin. (Jun., Nov. '30.) 341 South Mentor Ave., Pasadena, Calif.

Chenworth, Charles Francis. (Jun., Nov. '30.) Care, U.S. Coast and Geodetic Survey, Washington, D.C.

Clark, Linwood LeBoeuf. (Jun., Oct. '30.) Junior Engr., Interstate Commerce Comm., Washington, D.C.

Clifton, John Rodgers. (Jun., Nov. '30.) Asst. Engr., Dept. of Highways, Div. 6, 65 Thirteenth Ave., Columbus, Ohio.

Connell, Gilbert Fetterman. (Jun., Nov. '30.) 411 Hasting St., Pittsburgh, Pa.

Conti, Louis Francis. (Jun., Oct. '30.) 122 Hillside Ave., Berlin, N.H.

Courtney, Albert John. (M., Nov. '30.) Operating Mgr., Croos and Brown, Co., 270 Madison Ave., New York, N.Y.

Cranford, Elmo Leavines. (Jun., Nov. '30.) Transitman, Stone and Webster Eng. Corp., Wenatchee, Wash.

Dawson, Charles Oatley. (Jun., Nov. '30.) Instr. Dept. of Civ. Eng., Univ. of New Hampshire, Durham, N.H.

Deklotz, Leonard Anthony. (Jun., Oct. '30.) 2227 First St., N.W., Washington, D.C.

Denham, Glenn Adam. (Jun., Oct. '30.) 421 St. Anthony St., Baton Rouge, La.

DePue, Herbert. (Jun., Nov. '30.) 1718 Kilbourne Pl., N.W., Washington, D.C.

Dilberger, Charles Francis. (Jun., Nov. '30.) 209 Van Sicklen St., Brooklyn, N.Y.

Edge, Clarence Homer. (Assoc. M., Nov. '30.) City Engr., Holdenville, Okla.

Eichin, Henry. (Assoc. M., Nov. '30.) Mgr., Leo J. Ehrhart, Inc., 349 East 149th St., New York, N.Y.

Elwell, Otto Rae. (M., Oct. '30.) In Chg., Bridge Dept., State Highway Dept., Olympia, Wash

England, Arthur Clifford, Jr. (Jun., Nov. '30.) 34 Hartford St., Dorchester, Mass.

Evans, William Norman. (Jun., Nov. '30.) Engr., Rose and Evans, 219 North Olive Ave., Burbank, Calif.

Falk, Myron Samuel, Jr. (Jun., Nov. '30.) 126 East 70th St., New York, N.Y.

Feddersohn, Peter Longstaff. (Assoc. M., Oct. '30.) Asst. Constr. Engr., Los Angeles County Road Dept., 1403 South 3rd St., Alhambra, Calif.

Ferguson, Angus. (Assoc. M., Nov. '30.) Pres., Eastern States Bridge Co., Box 371, Concord, N.H.

Field, William Thompson. (M., Nov. '30.) Civ. Engr., 40 Flower Bldg., Watertown, N.Y.

Geiger, Charles David. (Jun., Nov. '30.) Asst. Engr., Wm. Ferguson, 152 Market St., Paterson, N.J.

Glover, Archibald Franklin. (Jun., Oct. '30.) Junior Draftsman, Grade 3, Board of Transportation, New York, N.Y.

Goldman, Joseph Lasker. (M., Nov. '30.) Civ. Engr., Robert and Co., Atlanta, Ga.

Goodman, Wallace Shufeldt. (Assoc. M., Nov. '30.) County Engr., Bexar County, 606 East Mulberry Ave., San Antonio, Tex.

Gotaas, Harold Benedict. (Jun., July '30.) 604 Park Rd., Ambridge, Pa.

Grayson, Lincoln Blaisdell. (Jun., Nov. '30.) Loftsman, Fore River Shipbuilding Corporation, Ltd., Quincy, Mass.

Greenepége, Serge Joseph. (Jun., Nov. '30.) Asst. Engr., New York and Queens Elec. Light and Power Co., 41-60 Bowne St., Flushing, N.Y.

Hamilton, Spencer Conn, Jr. (Assoc. M., Nov. '30.) Engr. of Surveys, Essex County, Hall of Records, Newark, N.J.

Hansen, Carl Christian. (Jun., Oct. '30.) 2136 Fifth, West, Seattle, Wash.

Harber, George Peyton. (Jun., Oct. '30.) Box 132, Stockton, Calif.

Hardy, Abby Wolverton. (Assoc. M., July '30.) Southwestern Vocational School, Dallas, Tex.

Hastrup, Harold Kay. (Assoc. M., Nov, '30.) Senior Structural Engr., Architects Office, Chicago Board of Education, Chicago, Ill.

Hatch, William Bell, Jr. (Jun., Nov. '30.) Box 36, Altadena, Calif.

Heath, Edward Herbert. (Assoc. M., Oct. '30.) Engr. of Constr., Gulf Refining Co., Pittsburgh, Pa.

Heiss, Edward August. (Jun., Oct. '30.) Engr., Wallace and Tiernan Co., 525 South Harvard Ave., Los Angeles, Calif.

Hely, Allen Grant. (Jun., Nov. '30.) Junior Engr., Water Resources Branch, U.S. Geological Survey, 608 City Hall, Asheville, N.C.

Henny, Arnold Lorentz. (Jun., Nov. '30.) 1221 Washington St., Denver, Colo.

Hill, Charles Lenord. (Assoc. M., Nov. '30.) Box 652, Reno, Nev.

Hitchings, Eben Godfrey. (Assoc. M., June '30.) Senior Draftsman with King County Engr., Seattle, Wash.

Hoffmann, Reyburn Paul. (Assoc. M., Oct. '30.) City Traffic Engr., Dept. of Streets and Sewer, St. Louis, Mo.

Horst, Anton Edward. (M., Nov. '30.) Secy.-Treas. and Gen. Mgr., Henry W. Horst Co., 1505 . .ce St., Philadelphia, Pa.

Hostrup, C. .istian Fredrick. (Assoc. M., Nov. '30.) Dist. Representative, The Pitometer Co., Room 1878, 50 Church St., New York, N.Y.

Howard, Christopher Cameron. (Jun., Nov. '30.) Deep Run, N.C.

Howell, Franklin Jonathan. (Jun., Nov. '30.) 490 Territorial Rd., Benton Harbor, Mich.

Jarcho, Saul Matri. (Jun., Nov. '30.) 2045 Mapes Ave., New York, N.Y.

Jochnowitz, Nathan. (Jun., Nov. '30.) Engr. Asst., Board of Transportation, 250 Hudson St., New York, N.Y.

Johns, Edward Allan. (Jun., Nov. '30.) 720 Fulton St., Jeffersonville, Ind.

Johnson, Arthur Fayette. (Jun., Oct. '30.) 630 West 7th St., Albany, Ore.

Johnson, Max Roland. (Jun., Nov. '30.) Instrumentman, Bureau of Reclamation, Adrian, Ore.

Johnson, Myron Otas, Jr. (Jun., Nov. '30.) Care, Phillips Petroleum Co., Bartlesville, Okla.

Josepsberg, Benjamin Rubin. (Jun., Nov. '30.) 2143 North Wanamaker St., Philadelphia, Pa.

Kelson, Mihills Olis Courtney. (Jun., Nov. '30.) Box 374, Woodland, Wash.

Kibbe, Leslie Arthur. (M., Nov. '30.) Const. Mgr., Warm Springs Constr. Co., 701 Peters Bldg., Atlanta, Ga.

Killian, Joseph Adolf. (M., Oct. '30.) Dist. Engr., Standard Oil Co. of California, 1674 Lower Grand Ave., Piedmont, Calif.

Kirkley, Lyndon Francis. (Jun., Oct. '30.) 6 Oakwood Rd., Crafton, Pa.

Kueffner, Herbert William. (M., Nov. '30.) Director of Public Works, City of Durham, Box 725, Durham, N.C.

Kuehl, Julius Alexander. (Assoc. M., Nov. '30.) Engr., Dept. of Public Utilities, Water Div., Tacoma, Wash.

Kwan, Parker. (Jun., Nov. '30.) Junior Draftsman, State Highway Comm., San Francisco, Calif.

Lang, John La Treyte. (Jun., Oct. '30.) With Am. Tank and Equipment Corp., Oklahoma City, Okla.

Leslie, Sydney Clyde. (Jun., Nov. '30.) Box 152, Ennis, Tex.

Lindblom, Clifford Theodore. (Jun., Nov. '30.) Surveyman, U.S. Engrs., Cincinnati Dist., Cincinnati, Ohio.

Lockhart, George Burgwin. (Jun., July '30.) Instrumentman, C. and O. Ry., Richmond, Va.

LONG, GORDON LUCAS. (Jun., Nov. '30.) Junior Hydr. Engr., State Div. of Water Resources, Sacramento, Calif.

LORENZ, MERRILL CHARLES. (Jun., Nov. '30.) Care Gould Constr. Co., 517 Wellman Ave., Davenport, Iowa.

MCCARTY, JOHN WESLEY. (Jun., Nov. '30.) 303 East Wood St., Paris, Ill.

MCEVER, WILLIAM LENTON. (Assoc. M., '30.) Chf. Engr., Nye Odorless Incinerator Corp., Albany, Ga.

MCFARLAND, WILLIAM GEORGE LEWIS. (Assoc. M., June '30.) With Purdy and Henderson Co., 45 East 17th St., Room 1701, New York, N.Y.

MCGLONE, ROY GILLESPIE. (M., Nov. '30.) Gen. Mgr. and Chf. Engr., Harbor Dept., City of Long Beach, Room 24, City Hall Annex, Long Beach, Calif.

MCHUGH, PATRICK HENRY. (Jun., Oct. '30.) Jun. Asst. Civ. Engr., Field Grade 1, Westchester County Highway Dept.; 26 Cowles Ave., Yonkers, N.Y.

MCNERNEY, GEORGE WILLARD. (Jun., Nov. '30.) St. Paul Park, Minn.

MADDEN, JOSEPH ALOYSIUS. (Assoc. M., Oct. '30.) Asst. Engr., Joint State Highway Dist. 12, 215 A St., Yuba City, Calif.

MARMER, HARRY AARON. (M., Oct. '30.) Asst. Chf., Div. of Tides and Currents, U.S. Coast and Geodetic Survey, Washington, D.C.

MARSTON, GEORGE ANDREWS. (Jun., Nov. '30.) 12 Marshall St., Turners Falls, Mass.

MATZKE, ARTHUR EDWARD. (Jun., Nov. '30.) 3190 Perry Ave., New York, N.Y.

MEEHAN, ANDREW JOSEPH ALOYSIUS. (Assoc. M., Nov. '30.) With State Div. of Highways, Sacramento, Calif.

MENDELL, DAN, JR. (Jun., Nov. '30.) 951 Merrill Ave., Houston, Tex.

MENNE, LEO ERNEST. (Jun., Nov. '30.) With Arthur McMullen Co., 50 Church St., New York, N.Y.

MICKLE, DAVID GRANT. (Jun., Nov. '30.) 21 Shepard St., Cambridge, Mass.

MONBECK, ROY ROYER. (M., Nov. '30.) Topographic Engr., U.S. Geological Survey, Washington, D.C.

MOORE, WALTER FRANCIS. (Assoc. M., June '30.) Asst. Engr., Kastenhuber and Anderson, Care, Water Works System, Oxford, Md.

MORE, JOHN TAYLOR. (Assoc. M., Nov. '30.) Res. Engr., City of Columbus, Columbus, Ohio.

MORRIS, ROBERT DELMER. (Jun., Oct. '30.) Draftsman, State Div. of Highways, Camp 12, Div. of Highways, Schilling, Calif.

MOTTO, DANIEL ANTHONY. (Jun., Nov. '30.) Eng. Asst., Grade 3, Board of Transportation, 117-14 Queens Boulevard, Long Island City, N.Y.

MOYER, WILLARD MOHR. (Jun., Nov. '30.) 348 Franklin St., Quakertown, Pa.

MURPHY, BERNARD DELBERT. (Jun., Oct. '30.) 206 North Race St., Urbana, Ill.

NIEMEN, ELMER JACOB. (Jun., Oct. '30.) Asst. Engr., City of Tacoma, City Camp B, Potlatch, Wash.

ORTEGA-ROSADO, ENRIQUE. (Assoc. M., Nov. '30.) Care, Dept. of the Interior, San Juan, Porto Rico.

PAINE, ALBERT WINSLOW. (M., June '30.) Dist. Engr., State Road Comm., Box 426, Huntington, W. Va.

PEEL, KENNETH PERCIVAL. (Jun., Oct. '30.) 1517 Fountain St., Alameda, Calif.

PIRRO, ARTHUR GEORGE. (Jun., June '30.) 26 Arcadia Ave., Albany, N.Y.

PITNEY, MARSHALL. (Jun., Oct. '30.) Care McClintic-Marshall Co., 7749 Dante Ave. Chicago, Ill.

POE, WILLIAM ALLEN. (Assoc. M., Nov. '30.) Field Engr., State Highway Comm., Little Rock, Ark.

POPE, HAROLD FRANK. (Assoc. M., June '30.) Senior Civ. Eng. Draftsman, Bridge Div., Los Angeles County Road Dept., 323 East Lomita, Glendale, Calif.

PRITCHARD, FRANCIS THOMAS. (Jun., Oct. '30.) With Standard Oil Co., San Francisco, Calif.

RAMEY, ALLEN. (Assoc. M., Nov. '30.) Draftsman, Ash, Howard, Tammen, and Needles, Kansas City, Mo.

RAMIREZ CERDA, ROBERTO. (Jun., June '30.) Draftsman, The J. G. White Eng. Corp., S. en C., San Juan de Letran 24-102, City of Mexico, Mex.

REED, TOM MARTIN. (M., June '30.) Chf. Engr., Bureau of Eng., Pittsburgh, Pa.

REED, WALTER HOWARD, JR. (Jun., Nov. '30.) 82-16 Hayes Ave., Apartment 1-E, Jackson Heights, N.Y.

REILLY, THOMAS GEORGE. (Assoc. M., Nov. '30.) Thomas G. Reilly and Frederic A. Reimer, Inc., 275 Bloomfield Ave., Caldwell, N.J.

REYNOLDS, GEORGE LAWRENCE. (Jun., Oct. '30.) Jun., Civ. Engr., Interstate Commerce Comm., Washington, D.C.

REYNOLDS, MATAMORE BEVERLY. (Jun., June '30.) Otten, N. Mex.

RHODES, DON MCKEE. (Jun., Oct. '30.) Broad St., Salamanca, N.Y.

RICHARDS, GUY. (Jun., Nov. '30.) Draftsman, Northwestern Power Co., Ltd., Winnipeg, Man., Canada.

RITTER, SAMUEL HENRY. (Jun., Nov. 10, '30.) 1211 Nebraska St., Sioux City, Iowa.

ROOS, ANDRÉ MÉRIT. (Assoc. M., Nov. '30.) With Hydro. Eng. and Chemical Co., Elizabeth, N.J.

ROSBERG, EDWARD OSCAR. (Jun., Oct. '30.) With Standard Oil Co., Richmond Refinery, Richmond, Calif.

ROWLEY, REGINALD. (Jun., July '30.) Designer, Am. Bridge Co., 1422 Frick Bldg., Pittsburgh, Pa.

RYAN, WILLIAM. (Assoc. M., Nov. '30.) Res. Engr., Highway Constr., City of San Francisco, City Engr's Office, San Francisco, Calif.

RYDEEN, JAMES PHILIP. (Jun., May '30.) Junior Engr., U.S. Geological Survey, Royston, Ga.

SALTZMAN, BENJAMIN. (Assoc. M., Nov. '30.) Asst. Engr., Bureau of Bldgs., Borough of Brooklyn, Brooklyn, N.Y.

SAMPSON, RAPHAEL. (Jun., Nov. '30.) Design Engr., State Dept. of Bridges, Sacramento, Calif.

SAMUEL, MYER. (Jun., Oct. '30.) 139 North Sheldon Ave., Ames, Iowa.

SCHEVE, CARL JULIUS. (Jun., Oct. '30.) Instr., Civ. Eng., Univ. of Colorado, 201 Eng. Bldg. No. 1, Boulder, Colo.

SCOTT, ARTHUR MORELAND. (M., Nov. '30.) Structural Engr., Ole K. Olsen, 325 North Cortez St., New Orleans, La.

SEVERS, ROSCOE FRYMIRE. (M., Nov. '30.) Care, Bureau of Valuation, Interstate Commerce Comm., Washington, D.C.

SHAMRAY, MICHAEL JACOBS. (M., Oct. '30.) Engr., George F. Hardy, 309 Broadway, New York, N.Y.

SHOCKLEY, DELL GEORGE. (Jun., Nov. '29.) 705 Eighteenth St., N.W., Apartment 920, Washington, D.C.

SISSONS, GORDON EARL. (Assoc. M., Oct. '30.) Chf. Draftsman, United Engrs. and Constructors, Inc., 112 North Broad St., Philadelphia, Pa.

SKINNER, ROBERT ALEXANDER. (Assoc. M., Oct. '30.) Senior Asst. Civ. Engr., Bureau of Eng., Los Angeles, Calif.

SLOANE, GEORGE GIST. (M., Nov. '30.) Structural Engr., Superv. Archt. Office, Treasury Dept., Washington, D.C.

SODERSTRAND, STYLES ARTHUR. (Jun., Nov. '30.) 456 Forty-fifth St., Oakland, Calif.

STEIN, JACOB ALEXANDER. (Assoc. M., Nov. '30.) Chf. Constr. Supt. and Engr., George Colon and Co., 103 East 125th St. New York, N.Y.

STEPHENS, CHARLES HENRY. (Jun., Nov. '30.) Asst. Engr., Dept. of Water, City of Dayton, Dayton, Ohio.

STOPP, CARL. (Jun., Nov. '30.) 7733 Weaver Ave., Maplewood, Mo.

STROHM, FRANK ALVIN. (Assoc. M., Nov. '30.) Field Engr., Atlantic Refining Co., 6111 Columbia Ave., Philadelphia, Pa.

STUNKARD, CLARENCE RUSSELL. (Jun., Oct. '30.) 325 Forty-fourth Ave., S. W., Seattle, Wash.

SWANSON, LEROY ALEXANDER. (Jun., Nov. '30.) Allerton House, Chicago, Ill.

THOMAS, SAMUEL ALVIN, JR. (Assoc. M., Oct. '30.) Asst. Res. Engr., City of Stockton, Stockton, Calif.

THOMASON, FRANK. (Jun., Nov. '30.) 1908 Wichata, Austin, Tex.

TRIGEIRO, WILLIAM FRANCIS. (Jun., Nov. '30.) 1759 Hyde St., San Francisco, Calif.

TUROFF, LOUIS WEBSTER. (Assoc. M., Oct. '30.) Asst. Highway Engr., U.S. Bureau of Public Roads, Box 1073, Juneau, Alaska.

TUTTLE, IRA GRAY. (Assoc. M., Nov. '30.) Box 276, Monroe, N.C.

ULRICH, FRANKLIN PETER. (Assoc. M., June '30.) Magnetic Observer, U.S. Coast and Geodetic Survey, Sitka Magnetic Observatory, Sitka, Alaska.

VAN LONDON, WILLIAM JAMES. (Assoc. M., Nov. '30.) Res. Engr., State Highway Dept., Box 1416, Abilene, Tex.

VAN ZANDT, WILLIAM KEESEE. (Jun., Nov. '30.) Eng. Div., Water Dept., Houston, Tex.

VEATCH, FRED MILTON. (Assoc. M., June '30.) Asst. Engr., Water Resources Branch, U.S. Geological Survey, 4th Floor Federal Bldg., Boise, Idaho.

VIOLA, FELIX. (Jun., Nov. '30.) Designer and Detailer, N. Y. C. R. R., New York, N.Y.

VON SCHOELER, VICTOR JOSEPH. (Assoc. M., Nov. '30.) Asst. Engr., New Mexico Div., S. P. Co., Box 1103, El Paso, Tex.

WADDELL, CHARLES EDWARD, JR. (Jun., Nov. '30.) Biltmore, N.C.

WALLACH, CARL DOUGLASS. (M., June '30.) Structural Engr., H. G. Balcom, New York, N.Y.

WALLIS, WILLIAM TURNER, JR. (Assoc. M., Oct. '30.) Pres., Wallis Eng. Co., Box 1862, West Palm Beach, Fla.

WARTHEN, MAURICE ALVIN. (Assoc. M., Nov. '30.) Engr., The Grier-Lowrance Constr. Co., 1002 Hill Bldg., Washington, D.C.

WAUGH, WILLIAM RUSHING. (Jun., Nov. '30.) Asst. Engr., Allied Engrs., Inc., Milledgeville, Ga.

WEBER, PHILIP ANTOINE. (Jun., Oct. '30.) With U.S. Coast and Geodetic Survey, 3118 Magazine St., New Orleans, La.

WEINMAN, SAMUEL. (Assoc. M., Oct. '30.) Designer and Chf. Draftsman, Oltarsh Eng. Co., New York, N.Y.

WEST, GORDON RUSSELL. (Assoc. M., Nov. '30.) Reclamation Engr., Mo. Pac. Lines, St. Louis, Mo.

WESTELL, JOSEPH, JR. (Jun., Nov. '30.) 82-16 Hayes Ave., Jackson Heights, N.Y.

WESTFALL, LEO BAKER. (Assoc. M., Nov. '30.) Designing Engr., Hudson River Regulating Dist., Maple Ave., Altamont, N.Y.

WETHERELL, JOHN GAMBLE. (M., Nov. '30.) Asst. Engr., C. M. St. P. and P. R. R., Milwaukee, Wis.

WILLIER, GEORGE JOSEPH. (Jun., Oct. '30.) Asst. Valuation Engr., State Public Service Comm., 430 Poplar St., Springfield, Mo.

WOOLLEY, LOGAN HOWARD. (Jun., Nov. '30.) Engr., S. J. Cohen and Co., Blytheville, Ark.

WURTS, WILLIAM ALFRED DUBOIS. (Assoc. M., Nov. '30.) Senior Asst. Engr., Sewer and Bridge Div., Hartford, Conn.

ZEESE, ROBERT KENNETH. (Jun., Nov. '30.) 1328 Columbia Rd., N.W., Washington, D.C.

### MEMBERSHIP TRANSFERS

BALL, ETHAN FRANK. (Assoc. M., '21; M., Nov. '30.) Engr., McClintic-Marshall Co., Pittsburgh, Pa.

BEAL, CHARLES HOCTOR. (Jun., '26; Assoc. M., Nov. '30.) Field Engr., City of Omaha, Omaha, Nebr.

BREHM, GEORGE CHARLES. (Assoc. M., '24; M., Oct. '30.) With Eng. Dept., Met. Dist. Comm., Park Div., Boston, Mass.

Brockmann, Herman. (Jun., '23; Assoc. M., Oct. '30.) Engr., Sanderson and Porter, Oroya, Peru.

Bullen, Carroll Alling. (Jun. '25; Assoc. M., Aug. '30.) Chf. Engr., Dolese Bros. Co., Oklahoma City, Okla.

Canals, José Manuel. (Jun., '27; Assoc. M., Nov. '30.) Gen. Contr., P. O. Box 1185, San Juan, Porto Rico.

Carey, Frank Culpin. (Assoc. M., '27; M., Sept. '30.) Senior Engr., U.S. Engr. Office, Foot of Prytania St., New Orleans, La.

Cavanagh, William Curran, Jr. (Jun., '29; Assoc. M., Nov. '30.) With Stone and Webster Eng. Corp., Box 1454, Wenatchee, Wash.

Feinstein, Emanuel Mandel. (Jun., '26; Assoc. M., June '30.) With The Austin Co., Chicago, Ill.

Geldert, Leonard Dunbar. (Jun., '25; Assoc. M., Nov. '30.) Structural Engr., Shippers' Car Line Corp., Milton, Pa.

Hale, Hal Henderson. (Jun., '25; Assoc. M., Oct. '30.) Office Engr., City Engr's. Office, Knoxville, Tenn.

Hodges, McCloud Bradford. (Assoc. M., '27; M., Nov. '30.) Res. Engr., State Highway Dept., Freestone and Limestone Counties, Box 768, Teague, Tex.

Koch, Walter Kurt. (Jun., '28; Assoc. M., Nov. '30.) Asst. Engr., Westchester County Park Comm., Pleasantville, N.Y.

Lafferty, Burns. (Jun., '29; Assoc. M., Nov. '30.) Supt., Harris Gramm, Inc., 176 East Tulpehocken St., Philadelphia, Pa.

Marden, Leslie Oma. (Assoc. M., '19; M., Nov. '30.) County Engr., Worcester County, 19 Court St., Worcester, Mass.

Owens, Reuben Hirst. (Jun., '27; Assoc. M., Jun. '30.) Senior Civ. Eng. Draftsman, Bureau of Eng., City and County of San Francisco, Room 351, City Hall, San Francisco, Calif.

Robinson, Onslow Stewart. (Jun. '26; Assoc. M., Nov. '30.) Res. Engr., Parklap Constr. Corp., and Parsons, Klapp, Brinckerhoff, and Douglas, Box 455, New Harmony, Ind.

Singleton, Charles Clayton. (Jun., '27; Assoc. M., Nov. '30.) Squad Leader, Office, Engr. of Elec. Traction, Reading Co., Room 550, Reading Terminal Bldg., Philadelphia, Pa.

Skinner, Alfred Edwin. (Assoc. M., '24; M., Nov. '30.) Dist. Mgr., The Pitometer Co., 5311 Kenmore Ave., Chicago, Ill.

Sturm, Rolland George. (Jun., '28; Assoc. M., Nov. '30.) 1722 Ridge Ave., Arnold, Pa.

Taub, Edward Samuel. (Assoc. M., '24; M., Nov. '30.) Div. Engr., Morris Knowles, Inc., 507 Westinghouse Bldg., Pittsburgh, Pa.

### Reinstatements

Magor, Basil, M., reinstated Nov. '30.

### Resignations

Davin, Joseph William, Assoc. M., resigned Dec. '30.

Haskell, William Cook, Affiliate, resigned Dec. '30.

Kahn, Moritz, Assoc. M., resigned Dec. '30.

Waldron, Albert Edwin, M., resigned Dec. '30.

### Deaths

Braune, Gustave Maurice. Elected Jun., June 2, 1896; Assoc. M., Sept. 4, 1901; M., May 15, 1917; Director, 1925–1927; died November 26, 1930.

Burr, Henry Amsden. Elected Assoc. M., Jan. 15, 1923; M., Oct. 10, 1927; died June 20, 1930.

Cain, William. Elected M., Nov. 7, 1888; died Dec. 7, 1930.

Eckersley, Joseph Oscar. Elected M., Aug. 31, 1909; died Nov. 19, 1930.

Fehr, Harrison Robert. Elected M., Oct. 5, 1898; died May 30, 1930.

Gerdine, Thomas Golding. Elected M., June 6, 1921; died Oct. 31, 1930.

Hibbard, Merrill. Elected M., Mar. 9, 1920; died Oct. 10, 1930.

Hunt, Andrew Murray. M., Feb. 7, 1906; died Dec. 8, 1930.

McCarthy, George Arnold. Elected M., Nov. 6, 1907; died Nov. 13, 1930.

Pugh, Marshall Rogers. Elected Assoc. M., Dec. 7, 1904; M., Nov. 2, 1908; died Nov. 22, 1930.

Rogers, Joseph Warren. Elected Assoc. M., Oct. 1, 1912; died Nov. 21, 1930.

Whitaker, William Franklin. Elected Jun., Apr. 4, 1905; Assoc. M., Sept. 6, 1910; died Nov. 20, 1930.

Whitfield, James Edward. Elected M., Mar. 2, 1904; died Nov. 4, 1930.

Yolton, Robert Elgene. Elected Assoc. M., Apr. 17, 1917; died Sept. 10, 1930.

### Total Membership as of December 10, 1930

| | |
|---|---|
| Members | 5,830 |
| Associate Members | 6,192 |
| Corporate Members | 12,022 |
| Honorary Members | 17 |
| Juniors | 2,489 |
| Affiliates | 138 |
| Fellows | 7 |
| Total | 14,673 |

# Men and Positions Available

*These items are from information furnished by the Engineering Societies Employment Service with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fees is to be found on page 87 of the 1930 Year Book of the Society. Unless otherwise noted, replies should be addressed to the key number, Engineering Societies Employment Service, 31 West 39th Street, New York, N.Y.*

Recent Graduate; Jun. Am. Soc. C.E.; age 24; single. Two years experience in detail drafting with Pennsylvania Railroad; 1 year experience in surveying. Speaks French and German. Willing to work in either field or office, or to go on road as salesman. Location immaterial. C-7928.

Construction Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer; graduate Worcester Polytechnic Institute; 30; married. Eight years experience designing, estimating, and managing construction of high-class buildings; 2 years in Latin America; speaks Spanish. Desires executive position with leading architects or contractors. Excellent references; available immediately for United States or foreign countries. C-7542.

Civil Engineer; Jun. Am. Soc. C.E.; Rensselaer graduate, wants permanent connection with sewer or water works engineer, municipal or consultant. Location immaterial. Two and one-half years surveying experience; 6 months junior engineer in charge of construction on large sewer project; 6 months with consultant on water works design. C-8365.

Civil Engineer; Jun. Am. Soc. C.E.; 1926 graduate; married; Long Island resident; desires work in sanitation on Long Island or in New York City. C-2620.

Municipal Engineer; Jun. Am. Soc. C.E.; licensed New Jersey; 28; married; graduate Lehigh University. Five years experience title, topographical, triangulation, sub-division, hydrographic surveys, sewage ponds, streets, curbs, sidewalks, drainage, dredging, gravel roads. Last 3 years in private practice. Prefers position as assistant or city engineer. Location East. Available at once. B-8919.

Civil Engineer; Jun. Am. Soc. C.E.; 1923 graduate; $4^1/_2$ years experience on tunnel construction, as chief of survey party; $1^1/_2$ years on power house construction, as field engineer; and 1 year on rapid-transit planning; seeks position giving design experience. C-8399.

Civil Engineer; M. Am. Soc. C.E.; desires association in consulting field; New York State license; 25 years on construction of public works, such as New York subways, Catskill aqueduct, and others; 8 years on design, investigations, and reports in connection with sewerage, stream flow and flood control. B-767.

Civil Engineer; Assoc. M. Am. Soc. C.E.; age 44; single; open for immediate connection. Graduate engineer; 20 years varied experience in surveys, construction, railroad maintenance, and valuation. Prefers location in South, but will go anywhere. C-8438.

Civil Engineer; Jun. Am. Soc. C.E.; 24; single; degree from Rensselaer Polytechnic Institute, 1928. Experience of $2^1/_2$ years, locating, designing, detailing, and estimating steel, concrete, and timber bridges. Desires field or office position, any branch of structural work. Will go anywhere. Available on one week's notice. Excellent references from present employer. C-7469.

Structural Designer and Estimator; Assoc. M. Am. Soc. C.E.; college graduate; licensed professional engineer; 38; married; 10 years European and $6^1/_2$ years New York City experience. Open for permanent connection. C-4607.

Graduate Civil Engineer; Jun. Am. Soc. C.E.; 26; 4 years experience in layout and construction of office buildings, theaters, hotels, and apartment houses in Metropolitan area, as engineer and assistant superintendent with large building construction company. Desires position with contractor, engineer, or architect; field or office work. Employed now, but available immediately. C-3233.

Construction Executive; M. Am. Soc. C.E.; age 47; experienced, draglines, steam shovels, suction dredges, and other excavating equipment, drainage and irrigation, tunnel and canal lining, quarry work and river channel control; cost keeping and accounting. Expert in problems of organization. Available immediately. Location secondary. Highest references. B-4138.

Civil Engineer; Jun. Am. Soc. C.E.; university graduate; 27; married; 4 years experience in estimating, designing, and detailing of structural steel for various types of commercial and industrial buildings, particularly of mill variety and miscellaneous iron work. Desires connection with consulting engineer, structural firm, or teaching. Available at once. C-8433.

Graduate Civil Engineer; $2^1/_2$ years experience General Motors Export Co., junior executive and efficiency studies, also outside assistant superintendent with a construction corporation specializing in reinforced concrete, New York City. Desires field or office position, preferably with engineering or construction firm in New York. C-8465.

Civil Engineer; Assoc. M. Am. Soc. C.E. 20 years experience; executive type with outstanding record of accomplishment; 12 years in Latin American countries, with a broad experience on highway- and railroad-location and construction; harbor development; municipal improvements; investigations and reports; negotiated several large foreign contracts. Location secondary. B-4130.

ENGINEER; Assoc. M. Am. Soc. C.E.; 35; married, seeks industrial and investment analysis work with established organization. Banking and professional references best and conclusive. Fourteen years varied experience in United States, Latin America, Europe, Orient. Graduate. Speaks Spanish, French. Work has included industrial analyses, reports, cost finding, all phases financing projects, and foreign investigations. Good organizer and cooperator. C-6258.

CONSTRUCTION ENGINEER OR SUPERINTENDENT; M. Am. Soc. C.E.; over 30 years experience going abroad to build railways, hydro-electric projects, reinforced concrete, wharves, and industrial buildings. Experience in West Indies, South America, France, and Far East. Speaks Spanish. Can handle by administration or supervise local contractors, write specifications, and make contracts. Will go anywhere. A-5380.

EXECUTIVE ENGINEER; M. Am. Soc. C.E.; 41; graduate civil engineer with degrees. Broad experience in structural and industrial work including allied mechanical lines. B-6046.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; college graduate, 1926; age 27; single. Experience in surveying, and valuation, in highway, bridge, and building construction. Two years in South America in charge of construction of oil storage, tank farm, and general terminal construction. Location immaterial. C-2971.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; 14 years experience; just back from South America; desires responsible position, preferably on highway or railroad construction or location; considerable experience in general and triangulation surveys. Speaks and writes Spanish and French. Location immaterial. B-9765.

ENGINEER; Assoc. M. Am. Soc. C.E.; graduate in law and personnel administration; 20 years experience in construction, purchasing, promotion, and investigation. Seeks position, preferably in New York City, but will go elsewhere, where engineering experience and legal knowledge may be combined; local representative or limited traveling. B-5501.

CIVIL ENGINEER; M. Am. Soc. C.E.; 23 years experience in design and construction of steel and reinforced concrete bridges, buildings, railroads, and municipal works. Open for position as chief engineer, superintendent, or something similar. B-9497.

GENERAL SUPERINTENDENT BUILDING CONSTRUCTION; Assoc. M. Am. Soc. C.E.; age 42; construction manager, estimator, or similar capacity. Mature experience on all kinds of buildings; 15 years in responsible charge. Seven years with present employers, a nationally known company. All references; now located New Jersey. Willing to move. B-6228.

ESTIMATOR; Assoc. M. Am. Soc. C.E.; graduate structural engineer, Massachusetts Institute of Technology; 35; married; desires position with small or medium-sized construction firm as office man. Twelve years practical experience estimating, designing, and taking care subcontractors on all types of structure. Intimate knowledge of all phases of contracting. Excellent references. Will consider profit-sharing arrangement, with extremely low salary. B-1168.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 26; single; B.S. in engineering, State University of Iowa; 1 year teaching fellow, University of Minnesota; 2 years experience. Desires position working at sanitary or any other civil engineering design. Can furnish references. C-8486.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 27; single; will consider accepting position in any locality, domestic or foreign. Has had responsible charge of location, design, and construction on 80 miles of highway, partly in flat and partly in mountainous country. Has also had some experience on waterway surveys. C-1977.

STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; university graduate; age 32; married; 7 1/2 years experience with fabricators and railroad; experience includes work on large bridges and industrial buildings; thoroughly conversant with fabricating practice. Desires position as sales engineer or designer. A-3840.

CIVIL ENGINEER; graduate; age 30; single; American; 7 years experience in design and construction of highways, municipal improvements, reclamation projects, irrigation, and drainage. Good practical knowledge of electrical and mechanical machinery. Location, domestic or foreign. Speaks Spanish. Available at present. C-8421.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 26; graduate of Massachusetts Institute of Technology, 1926. Experience in structural steel design, underpinning on subway routes in field and office, preliminary studies and designs for hydro-electric project. Experienced in hydraulic laboratory investigations. Well recommended. C-2415.

DESIGNING ENGINEER; Assoc. M. Am. Soc. C.E.; age 33; several years experience in structural steel and reinforced concrete structures, including bridges, buildings, and bulkhead piers. Also 1 year field experience in sewer construction, and 2 years experience in administrative work in charge of road maintenance division. Writes and speaks Spanish fluently. A-4279.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate Lehigh University, 1926; 26; married; experience in municipal work, deep foundation work, and concrete design. Employed as estimator for large contracting firm and also as resident engineer. Now employed as chief draftsman on municipal works. Desires office employment. C-4930.

CIVIL ENGINEER; recent graduate; 24; single; 6 months experience in drafting and field work; desires connection with engineering or construction company. C-8434.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; graduate of excellent technical institution, 1929; age 25; single; experience in construction. Has business ability and sales personality. Desires to make permanent connection in industry. Location immaterial. Available immediately. C-6879.

CIVIL ENGINEER, CONSTRUCTION MANAGER, RESIDENT ENGINEER, CHIEF DRAFTSMAN; Assoc. M. Am. Soc. C.E.; 19 years experience, canals, railroads, industrial buildings and plants, water supply, large office buildings, stadium and baseball stands, hangars, airports and seaplane ports, gasoline and service stations, bulk plants. Worked for owner, engineer, and contractor. Qualified as organizer and executive. B-6758.

CIVIL ENGINEER; M. Am. Soc. C.E.; desires position with company or consulting firm; 1907 graduate; sound civil engineering judgment, acquired by extensive experience. Design and construction of industrial plants, buildings, and structures; investigations and general civil engineering problems. Experienced as chief engineer and construction manager. Has worked professionally in Latin-American countries as well as in United States. C-5629.

MUNICIPAL SANITARY ENGINEER; Assoc. M. Am. Soc. C.E.; Purdue; reciprocal registration; age 41; married; 23 years varied engineering experience, sewerage, water supply, drainage, flood control, paving, land development, investigations, appraisals, court testimony, estimates, and reports; 10 years in own practice. Available short notice to take charge of work anywhere. B-8357.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 26; single; University of Michigan; 3 1/2 years field and office experience, bridge design, bridge construction, highway and miscellaneous surveys. Most of experience on surveys. Can take charge of party on surveys or construction. Will locate anywhere. Available immediately. C-3244.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; age 30; American; 6 years experience building construction; 1 year in field; 5 years detailing, checking, and designing concrete and steel, and estimating. Available at once. C-8304.

GRADUATE CIVIL ENGINEER; M. Am. Soc. C.E.; 26 years experience, design, construction, and supervision water works, purification plants, reservoirs, concrete tanks, pumping stations, industrial buildings, pipe lines, and many other structures; 21 years responsible charge; 7 years contractor's superintendent; good executive; understands organization to get results. Desires position with municipality, contractor, or industrial company. C-5688.

STRUCTURAL STEEL AND REINFORCED CONCRETE DESIGNER; Jun. Am. Soc. C.E.; age 30; American; graduate in civil engineering, Massachusetts Institute of Technology. Experienced in design and construction of steel office buildings, industrial buildings, warehouses, and foundations. Desires responsible position with leading architects, consulting engineers, or contractors. Able to direct and to work independently. C-6533.

# RECENT BOOKS

*New books of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 77 and 78 of the Year Book for 1930. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.*

A.S.T.M. TENTATIVE STANDARDS, 1930. By American Society for Testing Materials. Philadelphia, The Society, 1930. 864 pp., illus., diagrs., tables, 9 × 6 in., paper, $7.00; cloth, $8.00.

This new edition contains 155 specifications and methods of testing that have not yet been adopted as standard by the Society, but are under consideration and are offered for criticism. They cover the whole field of engineering materials, there being specifications for various metals, cement, clay products, preservative coatings, road materials, insulating materials, coal, coke, and various other substances.

DESIGN OF STEEL STRUCTURES. By Leonard Church Urquhart and Charles Edward O'Rourke. New York, McGraw-Hill Book Co., 1930. 448 pp., illus., diagrs., tables, 9 × 6 in., cloth, $5.00.

A companion volume to *Stresses in Simple Structures*, dealing with design. After covering the fundamental topics, the author discusses roof trusses, plate girders, and truss bridges. Complete designs of various types are given, with full details. As far as possible, only elementary theory is used. A chapter is devoted to welding, and standard specifications for buildings and bridges are given.

ENGINEER'S VEST POCKET BOOK. By W. A. Thomas. Chicago, W. A. Thomas Co., 1930. 151 pp., illus., diagrs., tables, leather, $3.00.

This book is intended to provide a finger-tip reference for the busy engineer, give the student a perspective of engineering, and help the specialist in one field understand the viewpoint of the specialist in related fields.

GOETHALS, GENIUS OF THE PANAMA CANAL; A BIOGRAPHY. By Joseph Bucklin Bishop and Farnham Bishop. New York and London, Harper and Bros., 1930. 493 pp., illus., ports., 10 × 6 in., cloth, $5.00.

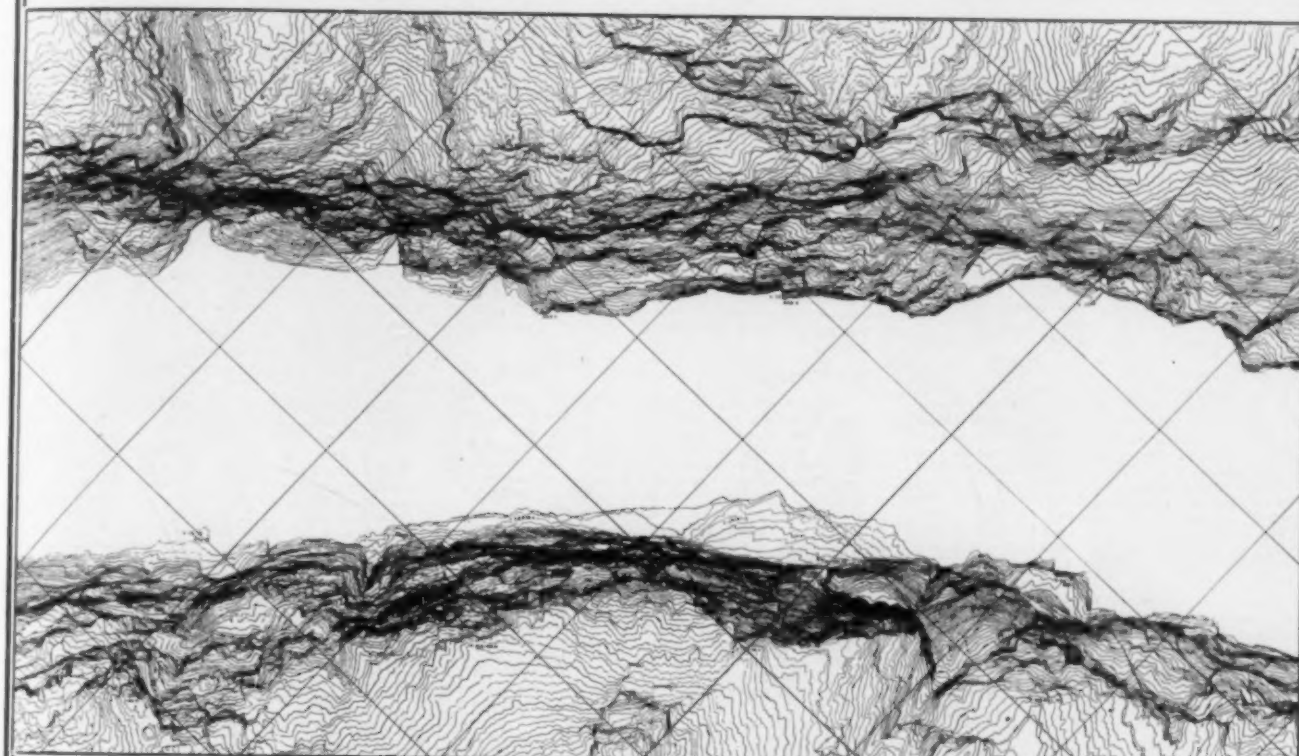
A vivid, interesting account of General Goethal's career covers his various activities at West Point, as an army engineer, at the head of the Panama Canal work, and in later life. The work is based on intimate acquaintance and access to many private sources of information, the senior author having been secretary of the Isthmian Canal Commission.

INTRODUCTION TO STRUCTURAL THEORY AND DESIGN; THEORY. By Hale Sutherland and Harry Lake Bowman. New York, John Wiley and Sons, 1930, 318 pp., diagrs., tables, 9 × 6 in., cloth, $3.50.

The basic conceptions and principles of structural theory, relating to trusses, rigid frames, and space framework, are presented in this text, which is planned to cover the course in stress analysis usually given in American engineering schools. Special features are the use of the Bar Chain Method of Elastic Weights for computing truss deflections, and of Professor Cross' method of rigid frame analysis, and the presentation of a new method for approximating the wind stresses in tall building frames.

ROUTE SURVEYING. By George Wellington Pickels and Carroll Carson Wiley. New York, John Wiley and Sons, 1930. 380 pp., illus., diagrs., tables, 7 × 4 in., fabrikoid, $3.50.

A practical, concise textbook on route surveying for railroads, highways, pipe lines, and transmission lines. The book is intended for use as a textbook and as a manual for the practicing engineer. It replaces the authors *Textbook on Railroad Surveying*.



# CURRENT PERIODICAL LITERATURE

## *Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands*

*Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 1,800 technical publications are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this Library at the cost of reproduction, 25 cents per page, or technical translations of the complete text may be obtained when necessary at cost.*

### BRIDGES

Movable, Construction. Two Heavy Spans Floated into Place to Complete Hackensack River Bridges. *Eng. News-Rec.*, vol. 105, no. 20, Nov. 13, 1930, pp. 778–780, 5 figs. One highway and two railroad structures in close proximity put into service by schedule involving shifting of navigation channel and removal of three old crossings; new bridges have vertical lift spans; design of new bridges; placing through-truss span, 245 ft. long, on 43-deg. skew; opening new channel.

Piers, Construction. Pneumatic Caisson Foundations for Japanese Bridge, J. Masake. *Eng. News-Rec.*, vol. 105, no. 22, Nov. 27, 1930, pp. 848–850, 5 figs. Features of concrete arch bridge consisting of six spans 142 to 154 ft. in length; piers sunk through sand and gravel to depth of 80 ft. below water; decompression allowance for caisson men; test of bearing power under caisson.

Plate Girder. Rebuilding of Kettle Creek Viaduct, Michigan Central Railroad, J. E. Bebb and L. B. Alexander. *Can. Ry. and Mar. World (Toronto)*, no. 392, Oct. 1930, pp. 617–619, 4 figs. Construction of new bridge embodies distinctive features; project brings to light interesting record of railway-bridge history covering period of 56 years; elevation and plans used; 16 spans up to 75 ft. length; total length 855 ft.; total cost $689,000; substructure consists, with one exception, of tall concrete piers, uniformly spaced to support superstructure of double-track deck plate-girder spans carrying I-beam and steel-plate floor.

Railroad Reconstruction. The Quick Replacement of a Railway Bridge. *Engineer (Lond.)*, vol. 150, no. 3903, Oct. 31, 1930, p. 491. What is claimed to be a record in railway-bridge replacement was effected by Pearson and Knowles Engineering Co. at Liverpool, where 500-ton steel bridge was substituted for 100-ton structure.

Steel Piles. Steel H-Beam Piles Used to Support Highway Bridges, W. E. Emmett. *Eng. News-Rec.*, vol. 105, no. 20, Nov. 13, 1930, pp. 764–765, 2 figs. Use of steel piles of H-section to support two highway bridges in Monterey, Calif.; structures consist of four-pile bents, spaced 40 ft., supporting steel stringers carrying $8^1/_2$-in. concrete floor slab; H-sections in gravel have 30-ton capacity; welded cross bracing completes trestle bents. Editorial comment on p. 756.

Steel Truss, Construction. Guy Derricks Simplify Erection of Cantilever Bridge. *Construction Methods*, vol. 12, no. 11, Nov. 1930, pp. 54–55, 6 figs. Report on erection of Rochester-Monaca cantilever bridge across Ohio River; guy derricks which set all steel in four spans of structure were light and required little reinforcing of cantilever arms to erect steel to center of suspended spans; bridge has main span of 780 ft., anchor span of 480 ft., and end spans of 540 and 360 ft.; suspended spans 300 ft. long are included in main span and in 540-ft. end span.

Suspension, Construction. Timber Falsework Used to Erect Suspension Bridge Towers. *Eng. News-Rec.*, vol. 105, no. 20, Nov. 13, 1930, p. 770, 2 figs. Notes on erection of steel towers for St. John's suspension bridge over Willamette River, at Portland, Ore., by use of derricks resting on tall timber falsework; each falsework tower resting on 56 piles, 100 ft. long, was erected by means of guy derrick acting in form of creeper traveler inside frame; wood bents were assembled on ground in 40-ft. sections and lifted into position by guy derrick.

### BUILDINGS

Air Conditioning. Air Conditioning Movie Theaters, M. Tomlinson. *Heat, Piping and Air Conditioning*, vol. 2, no. 11, Nov. 1930, pp. 934–936. Problems of synchronizing inside air temperature with outside weather conditions; consideration of human comfort; article presents problems before industry and profession.

High, Plumbing. How the World's Tallest Building Handles Its Drainage. *Plumbers Trade Jl.*, vol. 89, no. 10, Nov. 15, 1930, pp. 17–19, 9 figs. New plumbing problems in Empire State Office Building, which is 86 stories high, towering some 1,200 ft.; design of drainage system; vents of uniform size.

High Wind Bracing. High Wind Pressures on Tall Structures, A. M. Thomas. *Science et Industrie (Paris)*, vol. 14, no. 201, Oct. 1930, pp. 789–794, 5 figs. French translation of paper previously indexed from World Power, July 1930.

Wind Bracing. Design of Wind Bracing, E. Smulski. *Boston Soc. Civil Engrs.—Jl.*, vol. 17, no. 9, Nov. 1930, pp. 491–523 and (discussion) 524–537, 25 figs. Wind bracing for modern tall structures; formulas for their design; special attention to structural-steel buildings and to connections required between horizontal steel beams and steel columns forming wind-resisting frames.

### CONCRETE

Construction, Specifications. Construction Specifications for Concrete Work on the Small Job, A. R. Lord. *Am. Concrete Inst.—Jl.*, vol. 2, no. 1, Sept. 1930, pp. 65–97. Specification intended for use on small job on which full time inspection is not maintained, based on assumption that such work will be awarded by architect or engineer to honest contractors only.

Mixing. The Art of Concrete Making, R. H. H. Stanger. *Engineer (Lond.)*, vol. 150, no. 3903, Oct. 31, 1930, p. 491. Tests laid down in standard specifications are result of cooperation between scientist and manufacturer; chemists claim that portland cement is gel material subject to volume changes when moisture cement changes. It would appear, therefore, that engineer has it in his power, by proper knowledge of effect of curing, if not to eliminate, then certainly to control those movements which bring about cracking and crazing. Abstract of presidential address before Instn. Structural Engrs.

### CONSTRUCTION INDUSTRY

Costs. Unit Prices from Current Construction Bids. *Eng. News-Rec.*, vol. 105, no. 18, Oct. 30, 1930, pp. 711–712, 2 figs. Unit bid prices for two highway bridges in Washington State; 36-in. water pipe for Detroit, 4,700 ft. long; soft dredging in San Joaquin River, Calif.; 779,000 cu. yd. of sediment and sand; two 900,000-gal. cylindrical high-service steel standpipes, 90 ft. high by 42 ft. diam., for Dayton, Ohio; reinforced concrete sewer for Omaha, 1,750 ft. long.

Unit Prices from Current Construction Bids. *Eng. News-Rec.*, vol. 105, no. 21, Nov. 20, 1930, pp. 831–832, 4 figs. Unit prices bid and description of following: C.-I. sewer on timber trestle at Great Neck, N. Y.; monolithic storm sewer in Tulsa, Okla.; dredging in St. Mary's River, Mich.; post office in Lafayette, Ind.; State road work in Florida.

### DAMS

Boulder. The Boulder Canyon Project. *Eng. and Contracting*, vol. 69, no. 11, Nov. 1930, p. 398. Construction features of $165,000,000 dam and reservoir, irrigation canal, and power development by U. S. Bureau of Reclamation; Hoover dam will be about 727 ft. above foundation rock; power plant capacity will be 1,000,000 or 1,200,000 hp.; All-American canal will be 75 mi. long, and Coachella branch will be 115 mi. long; new town will be located about 6 mi. due west of dam site.

Concrete Arch. Memorandum on Arch-Dam Developments, L. Jorgensen. *Am. Concrete Inst.—Jl.*, vol. 2, no. 1, Sept. 1930, pp. 1–64, 22 figs. Record of recent developments in arch-dam design and construction in general and in constant-angle, arch-dam design in particular; Pacoima Dam stresses; Bullard's Bar Dam, plan and sections; Lost Creek Dam; details of Smith water stop; Concow Dam plan and section; derivation of constants for design of arch dams; Big Santa Anita Dam; Diablo Canyon Dam; installation of grout pipes and water stops.

Design. Comments on a Few Dams and Reservoirs; C. E. Grunsky. *Military Engr.*, vol. 22, no. 126, Nov.–Dec. 1930, pp. 525–530, 12 figs. Reminiscenses on design and construction of Lower Otay Dam, Croton Dam, Gatun and Alahuela Dams, LaHonda and MacMillan Reservoirs, etc.; work of Reclamation Service. (Continuation of serial.)

Earth, Failure. Corpus Christi Dam Fails with Loss of North Abutment Wall. *Eng. News-Rec.*, vol. 105, no. 22, Nov. 27, 1930, p. 861. News item on failure of new water-supply dam of city of Corpus Christi, Tex., located on Nueces River, with loss of north concrete abutment of spillway section and about half of earth embankment at that end of dam; damage estimated at $100,000; dam consists of two sections of rolled-fill embankment separated by concrete spillway of gravity section, having maximum height of 42 ft.

Earth, Utah. $3,000,000 Echo Dam Project, Huge Industrial Undertaking in Utah, Nears Completion, F. F. Smith. *Min. Rev.*, vol. 32, no. 19, Oct. 15, 1930, pp. 7–10, 2 figs. Unit of Salt Lake Basin project will supply 80,000 acres with supplemental water for irrigation; earth-and-rock-fill structure 125 ft. high above original river bed and 151 ft. high above bedrock; crest length is 1,887 ft.; 60,000 cu. yd. of dam stripping, 1,350,000 of earth-fill, 250,000 of rock fill, 50,000 of dumped riprap on face of dam, 8,900 cu. yd. of concrete, 400,000 lb. of reinforcing steel, and 877,000 of metal work. Reprinted from Utah Engr., Sept. 1930.

Reservoirs. Board of Water Supply of the City of New York—Contract no. 231, 1930, 49 pp., 9 figs. on supp. plates. Information for bidders, forms of bid, contract, bond and certificates, specifications and drawings for furnishing and delivering 5-ft. by 15-ft. sluice gates, overflow gates plug valves, operating mechanisms, drive-shafting, and appurtenances for uptake and down-take chambers at Hill View reservoir.

### FLOOD CONTROL

Great Britain. Control of Floods in the Thames Valley, A. B. Buckley. *Water and Water Eng. (Lond.)*, vol. 32, no. 383, Nov. 30, 1930, pp. 510–515, 3 figs. Possibility of abating floods by storing surplus water in natural reservoirs; characteristics of Thames floods; impoundable volume in March and April; dates and volumes of maximum Teddington floods since 1904; summer storage.

Levees, Protection. Engineering Devices for Levee Protection in High Water, H. V. Pittman. *Eng. News-Rec.*, vol. 105, no. 18, Oct. 30, 1930, pp. 691–695, 7 figs. Area Engineer, Memphis Engineer District, Helena, Ark., describes organization and equipment constantly prepared for quick mobilization when levee is menaced by rising flood waters; general emergency procedure; weaving emergency mattresses; fighting Knowlton crevasse; sacking sand boil; brushing and sacking sloughs; movable wave-wash protection; lumber and sandbag topping; mudbox topping; deflection dikes.

Mississippi River. Straightened Channel Proposed as Mississippi Flood Solution. *Eng. News-Rec.*, vol. 105, no. 18, Oct. 30, 1930, pp. 700–701, 1 fig.; see editorial comment on p. 676. Plan presented by G. S. Williams to American Engineering Council, proposing excavation of entirely new channel for river, beginning 10 mi. below Cairo, Ill., and extending to St. Delphine Landing, La., 9 mi. below Baton Rouge, La.; from this point, low water would be discharged through existing channel past New Orleans; in time of flood, water exceeding 1,250,000 sec-ft. would be by-passed through 50-mi. excavated channel to West Cote Blanche Bay.

The Defense Against Old Man River, R. K. Tomlin. *Construction Methods*, vol. 12, no. 11,


BUFFALO CITY HALL
Buffalo, N. Y.
7,600 TONS OF STEEL
By
McClintic-Marshall

Nov. 1930, pp. 58-61, 14 figs. Stabilization of caving banks by grading and paving with concrete of slopes above water line. (Continuation of serial.)

RIO GRANDE. Project of Rectification of Bravo River (Rio Grande) in the Juarez and El Paso Valley (Proyecto de rectificacion del rio Bravo en el Valle de Juarez, El Paso), A. Santacruz, Jr. *Irrigacion en Mexico (Mexico, D.F.)*, vol. 1, no. 6, Oct. 1930, pp. 44-53, 1 map, on supp. plate. After eight years of study of International Commission on Boundary between Mexico and United States, detailed project has been prepared by engineers of both countries; flood hazards are to be greatly reduced; principal technical characteristics of project are outlined.

RIVER IMPROVEMENTS. Missouri River Drift and Dikes, F. Y. Parker. *Eng. and Contracting*, vol. 69, no. 11, Nov. 1930, pp. 399-400, 4 figs. Experience with system of six dikes in Sni Bend, Missouri River, constructed for purpose of correcting channel alignment; why dikes fail; composition of drift.

SPILLWAYS, BONNET CARRÉ, LA. Design and Construction of Bonnet Carré Spillway, H. Swenholt. *Am. Concrete Inst.—Jl.*, vol. 2, no. 3, Nov. 1930, pp. 243-262, 7 figs. Report on construction of flood-control spillway 7,700 ft. long, with special reference to concrete; history; description and design of foundations, cut-off walls, abutments, weir, piers, needles; fore-apron and stilling basin, floodway and side levees; concrete testing and inspection; order of concrete construction; contracts.

## FLOW OF FLUIDS

PIPES. Simplified Determination of Line Pressure Drop, T. H. Chilton and R. P. Genereaux. *Chem. and Met. Eng.*, vol. 37, no. 11, Nov. 1930, pp. 689-690, 1 fig. Pipe-line calculations for fluids are easily made with alignment chart based on Fanning equation, with aid of data on friction factor involved.

## FOUNDATIONS

PILES, STEEL. Steel H-Beam Piles for Ocean Pier to Submarine Oil Wells, C. L. Roberts. *Eng. News-Rec.*, vol. 105, no. 220, Nov. 13, 1930, pp. 763-764, 3 figs. Weight against flotation combined with bending strength, small wave exposure, ease of protection, and ability to penetrate hard bottom lead to adoption of H-beams as piles for 1,800-ft. ocean pier, at Seacliff, near Santa Barbara, Calif.; driving H-piles; construction of foundation for oil-well derrick. Editorial comment on p. 756.

## HYDRO-ELECTRIC POWER PLANTS

GEORGIA. Water-Wheel Types Combined to Overcome Variations in Head and Flow. *Eng. News-Rec.*, vol. 105, no. 20, Nov. 13, 1930, pp. 758-760, 6 figs. Flint River power plant, Crisp County, Ga., operating head 12 to 30 ft., is equipped with water wheels of propeller type and Francis type making possible good efficiencies with high, low, and normal flows; two Francis turbines each are direct-connected to 3,000-kva. generator; two propeller-type wheels each drive 4,500 kva. generator; stilling pool at foot of concrete dam is designed to destroy energy of water falling 30 ft. Editorial comment, pp. 755-756.

WASHINGTON. Cushman Power Plant No. 2, for Tacoma. *West. Construction News*, vol. 5 no. 21, Nov. 10, 1930, pp. 538-543, 13 figs. Progress report on municipally owned hydro-electric power development on Skokomish River, with special reference to construction of concrete line tunnel 13,000 ft. long and 17 ft. in internal diam.; features of Larner differential surge tank and twin penstock.

## INLAND WATERWAYS

SOUTHERN UNITED STATES. A Boon to South Atlantic Port Traffic, H. Hayden. *Naut. Gaz.*, vol. 119, no. 19, Nov. 8, 1930, pp. 7-8 and 11. Lower freights, heavier water transportation, two-way cargoes, and safer navigation provided by Virginia-Carolina link in intercoastal waterway system, extending from Norfolk, Va., to Cape Fear River, 15 mi. below Wilmington, N.C.; will cost Federal Government $13,346,654 upon completion, will eliminate dangers to small vessels and barges off Cape Hatteras, Cape Lookout, and Frying Pan shoals, will place greatest ports in North and East in direct waterway communication with largest and smallest ports as far south as Wilmington; entire project ready in 1931.

WELLAND SHIP CANAL. Build Giant Gate Lifter for New Welland Canal. *Mar. Rev.*, vol. 60, no. 11, Nov. 1930, pp. 65-66, 1 fig. Mammoth lock gate lifter of 500 tons capacity, capable of lifting largest gate leaf used in new canal, will be located on Lake Ontario side of Lock no. 1; floating crane consists of steel pontoon, 90 ft. long, 66 ft. wide, and 26 ft. deep; main engine is 300-hp., forced-lubrication, totally-enclosed engine, direct connected to 200-kw., 230-volt, d. c. generator turning 400 r.p.m.

## PORTS AND MARITIME STRUCTURES

AIRPORTS, FLOATING. Man-Made Islands, J. T. W. Marshall. *Am. Arch.*, vol. 138, no. 2590, Dec. 1930, pp. 30-31 and 68 and 70, 2 figs. Features of floating seadromes contracted to be built in mid-Atlantic to service transatlantic seaplanes and to furnish hotel and restaurant facilities for their passengers; seadrome deck of steel, 70 ft. above sea level, 1,100 ft. long, 340 ft. wide in central zone, and 180 ft. wide at ends, is supported by 32 buoyancy tanks, located in relatively undisturbed water below wave action and connected to deck by means of stream-lined iron columns, whole forming deep truss of tubular struts and steel cable ties.

DOCKS, AUSTRALIA. An Australian-Built Floating Dock. *Engineer (Lond.)*, vol. 150, no. 3902, Oct. 24, 1930, p. 449, 2 figs. on p. 456. Dock has length of 420 ft. and allows depth of 26 ft. of water over keel blocks; it is capable of lifting vessels weighing up to 11,000 tons; available width of all three sections is 82 ft.

DOCKS, FISHING. Dock Improvements at Grimsby. *Shipbldg. and Shipg. Rec. (Lond.)*, vol. 36, no. 20, Nov. 13, 1930, pp. 586-587, 2 figs. New fishing dock at Grimsby is being constructed by arrangement between London and North-eastern Railway and Grimsby Corp., at cost of 1,500,000 pounds; to have water area of 37 acres; shipways and jetties for refitting and also special coaling appliances will be provided; on north side will be quay 2,200 ft. long.

FRANCE. The Port of Pallice near La Rochelle and Projects for Its Extension (Le port de la Rochelle-Pallice et ses projets d'extension), A. Pawlowski. *Génie Civil (Paris)*, vol. 97, no. 17, Oct. 25, 1930, pp. 405-410, 9 figs. Description of land-locked port and basin, 5 km. due west of La Rochelle; features of piers, breakwaters, sea-walls, etc., including subsurface petroleum piping; port-traffic statistics; fishing harbor; program of port extension, ways and means for its realization.

MOBILE, ALA. Mobile, Alabama. *World Ports*, vol. 19, no. 1, Nov. 1930, pp. 1-82, 36 figs., partly on supp. plate. City, port, and harbor improvements, as follows: inland waterways; Bates Field; Municipal Airport of Mobile; Mobile Oceanic Line; tropical services of the United Fruit Company; dry docks and shipbuilding companies; port services; steamship agencies at Mobile; steamship service from Mobile; consulates at Mobile; description, equipment, characteristics, of the autonomous port of Havre, G. Gallois.

## ROADS AND STREETS

CONCRETE, CONSTRUCTION. Constructing Construction Joints in Concrete Pavements, T. C. Thee. *Roads and Streets*, vol. 70, no. 11, Nov. 1930, pp. 401-402, 4 figs. Description of improved, labor-saving method devised on Wisconsin State-aid paving job; planes of weakness cut by one man with simple apparatus; appearance of job improved by use of new device.

CONSTRUCTION, CALIFORNIA. Pixley-Tipton Highway, California. *West. Construction News*, vol. 5, no. 21, Nov. 10, 1930, pp. 544-546, 9 figs. California construction company averages 950 tons per day on 8.6 mi. of asphaltic concrete pavement, in Tulare county; summary of time losses and their effect; notes on equipment and methods used in grading and in pavement construction.

CONSTRUCTION, TEXAS. Asphaltic Concrete on Caliche Sub-Base for Texas Road, J. E. Pirie. *Eng. News-Rec.*, vol. 105, no. 19, Nov. 6, 1930, pp. 729-730, 5 figs. Reports on construction of 17,358 mi. of road along rough crest of Callahan Divide in Shackelford County, Tex., local caliche beds and limestone for asphalt aggregate give excellent road surfacing combination for region without water.

DETERIORATION OF ASPHALT PAVEMENTS. Deterioration of Asphalt Pavements, H. L. Howe. *Can. Engr. (Toronto)*, vol. 59, no. 19, Nov. 4, 1930, pp. 605-607. Causes of cracking; prevention of hair cracking. Report of sub-committee at annual meeting of Assn. Asphalt-Paving Technologists.

EARTH. Earth Roads (Caminos de tierra), A. Foster. *Ingenieria (Buenos Aires)*, vol. 34, no. 8, Aug. 1930, pp. 311-322, 1 fig. Comment on deterioration of earth roads in plains of Argentina, largely due to lack of construction materials; advent of automotive vehicles has accentuated need for good roads; type of road section is illustrated, suitable for fills where rainfall is heavy; instead of central crown, slope from margins to center, with central gutter delivering to culvert drains.

EXPERIMENTAL, GREAT BRITAIN. Road-Surface Experiments. *Engineering (Lond.)*, vol. 130, no. 3381, Oct. 31, 1930, p. 565, 1 map. Ministry of Transport is investigating relative value of variety of surfaces from points of view of cost, wearing and non-skidding properties; and length of road on Kingston by-pass has been devoted to experimental work in this direction.

HANDLING MATERIALS. Handling Earth by Belts, W. F. Way. *Eng. News-Rec.*, vol. 105, no. 22, Nov. 27, 1930, pp. 838-840, 4 figs. Experience with Denny Hill re-grade project in Seattle, Wash., which involved taking 4,200,000 cu. yd. of material from center of city, shows that clean discharge results when conveyors and material are wet; effect of weather; equipment performance; operating costs; analysis of causes of delay.

HIGHWAY SYSTEMS, UNITED STATES. Highway Progress in the Dakotas and Wyoming. *Eng. News-Rec.*, vol. 105, no. 22, Nov. 27, 1930, pp. 841-843, 5 figs. Oil-gravel mix adopted by all three States as best surfacing possible at low cost; snow removal becoming expensive maintenance item.

Road Building and Maintenance in the Southwest, C. N. Conner. *Roads and Streets*, vol. 70, no. 11, Nov. 1930, pp. 390-391, 11 figs. Low-cost, road-construction practice in Arizona and other Southwestern States; charts showing division of Arizona maintenance dollar among items of expense and among roadway upkeep units, for paved and unpaved surfaces; area, population, and motor vehicles in Southwestern States; construction programs, mileage of existing types of highways.

PAVEMENT DESIGN. Concrete Pavements, D. J. Garland. *Instn. of Engrs. Australia—Jl. (Sydney)*, vol. 2, no. 10, Oct. 1930, pp. 396-397, 2 figs. Determination of thickness in relation to macadam pavements under similar foundation and traffic-loading conditions; formulas and numerical examples.

RELOCATION. Highway Relocation, W. A. Van Duzer. *Eng. News-Rec.*, vol. 105, no. 19, Nov. 6, 1930, p. 740. Discussion by T. P. Young of paper previously indexed from issue of Sept. 25, 1930.

RESURFACING ASPHALT PAVEMENTS. Resurfacing Streets by the Heater Method, R. A. MacGregor. *Pub. Works*, vol. 61, no. 11, Nov. 1930, pp. 43-44. Methods used and results obtained in New York and Philadelphia; both direct flame and indirect heat machines used during paving; street closed only eight hours a day for two or three days. Paper read before Engrs. Club, Philadelphia.

RESURFACING, MICHIGAN. Changing a Gravel Road to Asphaltic Gravel at Small Cost, L. Luke. *Pub. Works*, vol. 61, no. 11, Nov. 1930, pp. 32-34, 5 figs. Report on surfacing of 200 mi. of gravel roads in Macomb County, Michigan; specifications; mechanical analyses of aggregates after crushing; 5 to 5.7 per cent of asphalt is used in hot mixture; use of "road oil pre-mix plant," manufactured by Iowa Manufacturing Co., of Cedar Rapids, Iowa; gravel is heated to temperature of 250 to 300 deg. fahr. and is mixed in pug-mill with hot asphalt; cost of resurfacing with average length of haul of 11 mi.

## SEWERAGE AND SEWAGE DISPOSAL

BARRINGTON, N.J. Barrington Sewage Treatment Plant, E. Bender. *Pub. Works*, vol. 61, nos. 9, 10, and 11, Sept. 1930, pp. 33-34, 80 and 82, Oct., pp. 21-22, and 69-70, and (discussion) Nov., pp. 38-39, 8 figs. Sept.: Description of sewage disposal plant in Camden County, New Jersey, designed for future population of 6,000; clarified sewage is treated by mechanical aeration, and settled effluent is filtered through sand and chlorinated; sludge digestion tanks and glass covered drying beds. Oct.: Gas utilization; sludge drying beds. Nov.: Discussion by M. J. Blew.

CONSTRUCTION OF SEWERS. Line Drilling a Rock Trench. *Pub. Works*, vol. 61, no. 11, Nov. 1930, p. 29, 1 fig. Report on construction of sewer line in Joliet, Ill., 5,400 ft. of which were to be laid in rock trench 10 to 16 ft. deep; confining excavation to pay line to reduce cost and danger to adjacent structures; diagram showing arrangement of drill holes and method of drilling center shot holes with turn-table mounting.

EXPERIMENTAL, LOS ANGELES. Sewage Reclamation Plant for Los Angeles, R. F. Goudey. *West. Construction News*, vol. 5, no. 20, Oct. 25, 1930, pp. 519-525, 11 figs. Design and construction of experimental 200,000-gal. per day activated sludge plant employing separate sludge digestion, with one-third of final effluent carried through complete treatment; sewage reclamation; construction and operation costs; five spreading beds were constructed by removing top 15 in. of soil found at treatment plant site; sludge disposal.

GREAT BRITAIN. Rothwell U.D.C.—New Sewage Disposal Works. *Engineer (Lond.)*, vol. 150, no. 3902, Oct. 24, 1930, pp. 444-446, 5 figs. Engineers advised that best method of purification would be by settlement in tanks, followed by filtration through bacteria beds, on new site which adjoins original disposal works; effluent from coke ovens is not allowed to enter sewers; arrangements made by which liquid is pumped on to pit bank at Robin Hood Colliery, where it is distributed over wide area; pumps are of vertical-spindle "Stereophagus" type, specially designed to deal with crude sewage.

HIGHLANDS, N. J. Sewage Treatment Plant of Highlands, N. J., P. B. Streander. *Pub. Works*, vol. 61, no. 11, Nov. 1930, pp. 19-20, and 69-70, 3 figs. Design of sewage treatment for